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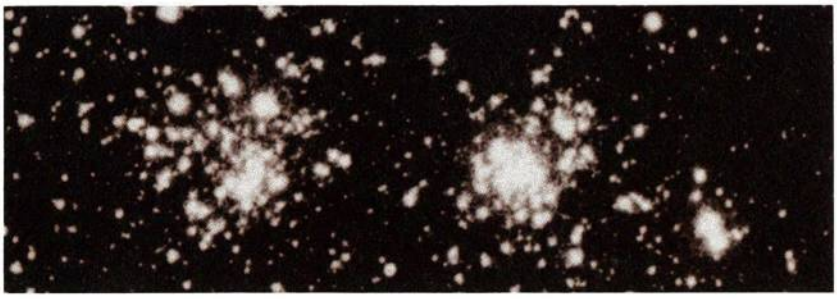

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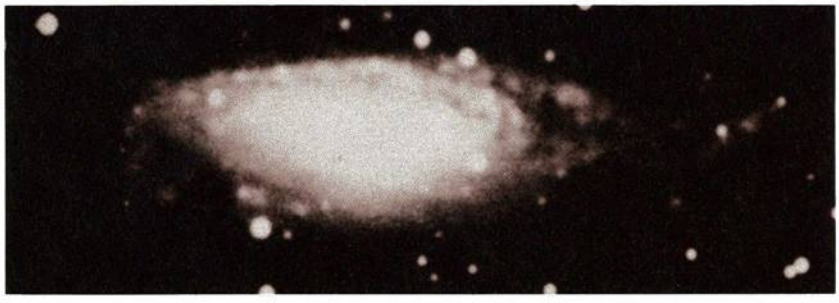
by F. Michael Witkoski

8 *One of the sky's brightest deep-sky objects, the Double Cluster in Perseus has been observed since creatures first turned heads skyward. In this article Mike Witkoski reveals all about h & χ.*



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THE MAGAZINE FOR
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AND ASTROPHOTOGRAPHERS

Fall 1986
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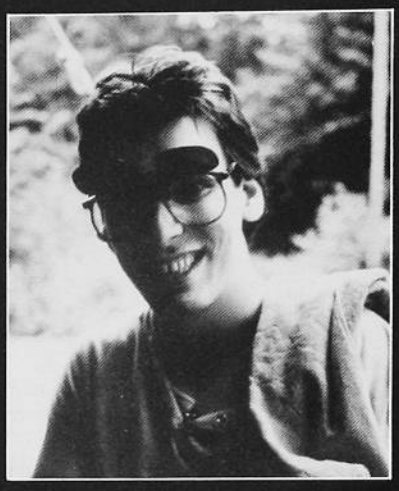
ON THE COVER: Galaxy NGC 7331 photographed by Martin C. Germano at Mt. Pinos, California; 8-inch f/10 SCT, 103a-F film, 120-minute exposure

Inside View

Convention Hopping



The major annual conventions of backyard astronomers do more than bring together observers from all around the country. Riverside, the Texas Star Party, Stellafane — each has its own character that gives amateurs incentive to carry on their adoration of the stars.

This year I was fortunate enough to attend two of the "Big Three": the TSP in Fort Davis, Texas, and Stellafane in Springfield, Vermont, held in May and August, respectively. This issue's third article, beginning on page 20, describes the people, events, talks, and telescopes of these two grandest amateur astronomy meetings. (As a preview, the word for this year's TSP was *hot*, while that for Stellafane was *drenched*.) For those planning a future vacation around Stellafane, a section of the article describes historical landmarks around the Boston area that I visited. Special thanks are due to Brian Skiff, who contributed material about the TSP and took many pictures, and to David Levy and Mike Witkoski, who took photos at Stellafane.

This issue's lead by Mike Witkoski details "everything you've ever wanted to know about the Double Cluster." Certainly this pair of objects is a favorite attraction of the autumn and winter Milky Way and will be widely observed this season. Let us know how you fare this fall observing colored stars, double stars, and variables in and around the region of this showpiece.

The feature article on page 14 is an exposé on the tiny, fuzzy galaxies near the spiral NGC 7331 in Pegasus. Floridian Jeffrey Corder and Californian Steven Gottlieb's piece identifies nebulous patches of light you may have seen in the vicinity of this popular galaxy.

Many of you undoubtedly observed the bright supernova in Centaurus A, clearly visible during early May. *Deep Sky* and *ASTRONOMY* received many photographs of the 12th-magnitude star set so nicely against the galaxy's broad, bisecting dust lane. A photo article on pages 35 and 36 of this issue highlights a selection of the best photos we received and includes a special supernova finding chart by Australian Gregg Thompson accurately marking the object's position. (An article by Gregg about supernova hunting will appear in an upcoming issue.)

The current edition of "Deep Sky Sketchbook" features drawings of globular clusters by the well-known Arizona observer Chris Schur. His excellent craftmanship in estimating appearances of stars and nebulous patches should serve as an example to all aspiring visual observers of clusters, nebulae, and galaxies.

Some *Deep Sky* readers evidently know that I was slightly injured in an automobile accident this year at Stellafane. Thanks to those of you who sent greetings . . .

Yours truly,

Dave Eicher
Editor

Letters to DSM

Supernova Discovery

Dear Sir / Enclosed is a photo of the recent supernova (1986G) in Centaurus A (NGC 5128), which I discovered on May 3. The plate was a IIaO, 10-minute exposure in relatively poor seeing conditions, taken by Dr. Colin Humphries about two hours after the discovery.

The discovery was made visually at my home address with a Meade DS 16 telescope supplied by the C.S.I.R.O.

The supernova was one of the brightest in recent years. Information about it appears in I.A.U. circulars 4208, 4210, 4215, 4216, and 4224.

Rev. Robert Evans
57 Talbot Road
Hazelbrook. 2779
NSW Australia

Swelled Stars and Supernova Shots

Dear Dave / I was very pleased to see my M83 photo on the cover of *Deep Sky #14*. When I first saw the cover I thought the stars looked excessively large, but after measuring the image scale I realized that it was a 20x enlargement. You did a very fine job of printing an originally 60" focal length photo at a scale of 1200"!

Jim Riffle
175 Piedra Loop
Los Alamos, NM 87544

P.S.: Enclosed are photos showing the supernova in NGC 5128 that was discovered by Rev. Robert Evans last Spring. They were made with a 12-inch f/5 AstroMak telescope and hypersensitized Tech Pan film. The exposure at left shows the galaxy a year before its supernova on May 23, 1985, and is a 45-minute exposure. The photo at right shows the galaxy with its supernova — inside the dust lane — at about 12th magnitude on May 12, 1986. It is a 60-minute exposure.

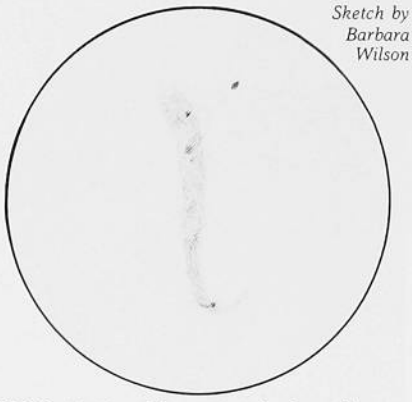
For Robert Evans' and Jim Riffle's photographs of supernova 1986G in Centaurus A, see page 35.

Fascination with NGC 4656

Dear David / It was a pleasure to meet you at the Texas Star Party in May. I am writing because you said you could send me the back issue of *Deep Sky* that references NGC 4656.

I have become totally fascinated by this strange galaxy and I would like to learn more.

Enclosed is a redrawing of my original drawing, with considerably added contrast. Please note that I had no prior



Sketch by Barbara Wilson

NGC 4656 with a 13.1-inch reflector

knowledge of this galaxy, nor had I ever seen a photo of it.

A member of the Houston Astronomical Society, Ken Drake, had suggested the galaxy as an interesting and challenging object. In his 10-inch Dobsonian we could not see the upper curve of the faint extension. The curve also was not visible in Don Pierce's fine 17.5-inch telescope, but I could see it in my 13.1-inch scope. This puzzles me. The faint extension was obvious in all three telescopes.

Barbara Wilson
Houston Astronomical Society
12346 Wellington Park
Houston, TX 770722

The Value of Back Issues

Dear Dave / I have recently renewed my subscription to *Deep Sky*. You may say, "that's great, but why tell me?" I'm writing you because I have made a mistake in judgment and wondered if you could help.

I previously received *Deep Sky* through subscription and Celestron purchases. I've been receiving *ASTRONOMY* since March 1974 and, in order to buy some old 1973 issues *ASTRONOMY* made available, I cancelled my subscription to *Deep Sky* (which I had paid through *#21*), and applied the credit toward four back issues of *ASTRONOMY*. Then I sold my existing *Deep Sky* issues *#1* and *#4-12* in Astromart.

I sold to the first caller and it was then that my problem struck home. I missed the magazine which is simple and enjoyable to read. The ongoing calls regarding my *Deep Sky* issues for sale never stopped, and that made me realize just how good a magazine *Deep Sky* really is.

When I resubscribed today, I bought back all the available back issues (*#4, #5, #7-10* and *#12*). Numbers *2* and *3* were never available when I previously received the magazine, but now *#1, #6,* and *#11* have also become unavailable.

Is there any way possible that there may still be some copies of those issues lying around in someone's desk in the office? I'd pay a premium to recapture something I previously had, now that I know how valuable this fine magazine is not only to me, but also to my peers.

Vincent G.Thayer
54 Larch Street
Carteret, NJ 07008

Dear Mr. Thayer / Thanks for your letter. I published it as a sample of many requests I am getting these days for old issues of Deep Sky. *Unfortunately I can't help at the moment. The press runs of earlier issues were so comparatively small and recent demand so great that no issues are left. I am hoping that soon, however, they will be reprinted. — DJE.*

Mount Kobau Star Party

Dear Sir / Once again the Okanagan Astronomical Society has hosted a successful star party on Mount Kobau. Approximately 200 people from all over North America attended this event, which was held July 31-August 4.

The weather was excellent on three of the four nights I attended; the skies were clear and very dark with occasional sporadic meteors and aurora borealis. On the evening of the third day on my way up the mountain I observed large thunderclouds forming, and approximately an hour later a spectacular lightning storm which struck a nearby antenna tower several times giving us a "fireworks" display to start the evening's viewing. The spectacle continued with the appearance of an impressive rainbow that formed soon after the storm. As the storm moved off into the distance a large forest fire could be seen its wake.

A great variety of telescopes were to be seen, ranging from 2.4-inch to 20-inch telescopes belonging to the Victoria and Calgary Centres, respectively. There was an abundance of hand-made Dobsonians, many of which were entered in the telescope-making contest.

The guest speakers who attended the star party included John Dobson of the San Francisco Sidewalk Astronomers who gave two talks: "The Nature of the Universe" and "Building Dobsonian Telescopes." Simon Hum of Quasar Optics in Calgary also gave an astrophotography lecture with slides, and David Dodge of the Vancouver Observatory gave a talk called the "The Astronomical Year in Review."

The Mount Kobau Star Party was a big success and the people who put it all into action are to be congratulated for a job well done. I hope that we may see more people next year enjoying the hot sunny days at Lake Okanagan in Osoyoos and the cool clear dark nights on top of Mount Kobau.

Malcolm Scrimger
R.A.S.C. Victoria Centre
Victoria, British Columbia, Canada

Marathons and Mopping

Dear David / I've heard and read a lot about Messier Marathons and Herschel Marathons in *Deep Sky* and other publications. I'm appalled by the thought. In a world where everything seems to go faster and faster, where whole books are written on Type-A behavior, and the mindless pursuit of quantity over quality dominates behavior, I'm saddened by the addition of marathons to amateur astronomy.

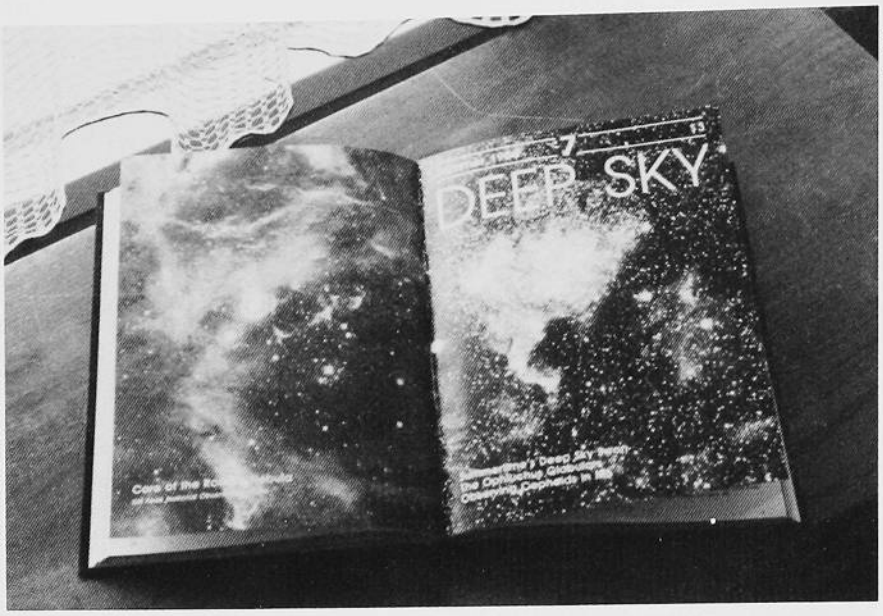
I can spend two hours looking at M42 for the hundredth time and never tire of the sight. A Messier Marathon is like going to the British Museum or the Louvre and "seeing everything" in two hours. If anyone out there is contemplating such a travesty, don't do it. It'll cost you more than you realize.

One practice reported in your magazine that I do enjoy is "constellation mopping." Maybe I can't finish a constellation in one night, since I don't feel that I've seen anything until I've sketched it, but so what? One of the biggest problems with constellation mopping is finding a decent atlas. I have had to resort to finding an old SAO atlas, enlarging it, and highlighting and labelling all those little diamonds that represent all the NGC and IC objects.

Why isn't there a good star atlas currently on the market? The *AAVSO Atlas* is virtually an enlarged reprint of the SAO without the 13,000 little diamonds. Maybe the *AAVSO Atlas* was a great idea, but it came slightly after its time. Besides making our own, is there any way deep-sky addicts can convince someone, maybe the AAVSO people if they print a second edition, to include at the very least the NGC/IC objects in an affordable sky atlas?

Also, *Deep Sky*'s use of epoch 2000 coordinates drives me nuts. I think most serious deep-sky observers (the kind who subscribe to this magazine) have progressed past Tirion's atlas and are using something like the SAO, Vehrenberg's photographic atlases, or have plotted objects on the *Skalnate Pleso* by hand. If you must include 2000 coordinates, print a duplicate column with 1950 coordinates. I know it takes up more space, but it would save a lot of us the trouble of converting or guessing.

R.J. Kirkland
15212-84 Avenue
Edmonton, Alberta, Canada T5R 3X8



Dick Talma

A clever and attractive method of preserving issues.

Preserving *Deep Sky* Issues

Dear Mr. Eicher / Enclosed are two photographs to show you how I save my copies of your wonderful magazine, *Deep Sky*. I bound twelve issues into a linen-covered book with the title *Deep Sky*. This is the way I save most of my magazines, like *Deep Sky, ASTRONOMY, Sky & Telescope,* and several others.

Dick S. Talma
Sparrendal 272
3142 LL Maassluis
The Netherlands

Planetary Addendum

Dear Dave / It was great to see you at the Texas Star Party. In answer to your question about the most memorable sight during the gathering, two items come to mind. The first was the galaxy cluster in Coma Berenices surrounding the elliptical NGC 4889 — I believe it's dubbed Abell 1656. Through Don Pierce's 17.5-inch Odyssey II telescope, coupled with a Nagler 13mm eyepiece (150x), I could easily see over thirty galaxies in the same field of view! With careful viewing the number rose to forty galaxies.

The second most memorable view was the faint planetary nebula IC 1295 in Scutum, an object lying right next to the globular NGC 6712. This 100" diameter planetary is very faint and lies in an extremely rich star field. When I looked for it in John Wagner's 20-inch telescope using a Lumicon Oxygen III filter, it looked to be at least 11th or 12th magnitude, with suggestions of faint streamers protruding a tiny distance from the ill-defined edges. A section was dimmer on one side, giving a quasi "C" shape.

In the lead article in *Deep Sky #15* I mentioned a number of planetaries that may not yet have been observed visually. At the Texas Star Party I looked for over sixty obscure planetaries, with a success rate of just over 50%. Thus, I saw about thirty that had in all likelihood never been seen before. Here are the sightings with estimated visual magnitudes in parentheses: Abell 38 (15.6), Henize 2-175 (15.0), Minkowski 2-6 (14.7), Minkowski 2-8 (14.7), Henize 2-198 (13.8), Haro 1-7 (13.5), Minkowski 3-36 (15.5), Minkowski 3-38 (15.5), Minkowski 2-11 (14.0), Cannon 1-3 (14.0), Cannon 1-4 (13.6), Minkowski 3-7 (15.7), Minkowski 3-9 (15.0), Minkowski 3-10 (14.2), Minkowski 2-10 (16.0), Henize 2-24 (15.5), Haro 1-26 (14.0), IC 4663 (12.3), Haro 1-36 (12.6), Henize 2-306 (14.0), and Cannon 3-1 (13.0).

Jack B. Marling, President
Lumicon, Inc.
2111 Research Drive
Livermore, CA 94550

Fan Letter

Dear Dave / I guess I should call myself a deep-down-to-the-nucleus deep-sky observer. I've only been involved with astronomy for twelve years and didn't start my deep-sky endeavors until 1979. I only recently purchased my first *Deep Sky* magazine — it's almost embarassing to say that I have cleared away over 1,000 observations before getting that first copy of the magazine! Since I have been running out of objects to observe from *Sky Atlas 2000.0*, it's *Deep Sky* magazine to the rescue. It's a fine magazine, and even with my college experience in graphics and journalism, I'd say you're doing a superior job.

Since observing Comet Halley a lot this past year, I'm getting back into deep-sky observing. Recently I've been performing surgery on the mounting for my 12.5-inch scope, so I've resorted to using my portable 8-inch scope and the 20-incher owned by the president of our

club. Early this month we took the 20-inch scope to its limit by observing the NGC 6027 galaxy group in Serpens. With a Nagler eyepiece all three galaxies were easily seen with averted vision. We also observed several other faint galaxies. Before leaving the observatory we decided to end the night by looking at M51 with a 24mm wide-field eyepiece. I've never before seen such fine detail in M51. It was a night of observing to remember.

Keep up the good work with *Deep Sky* magazine. I find it hard to survive without it.

Dan Sheber, Jr.
3240 Lancelot Lane
Green Bay, WI 54301

Any More Exotic Objects?

Dear Sir / After a year and two months, I have had success with some of the objects mentioned in the article, "21 Exotic Deep Sky Objects," in *Deep Sky #9*. On April 28, 1986, I went hunting for the quasar 3C 273 in Virgo with a Celestron 8 at 80x, and by using averted vision I saw its dim glow. I attempted to double the magnification by using a 2x Barlow, but the object was then rendered invisible due to a combination of reduced field, brightness, and light pollution. I marvelled to see the quasar, and I checked the position to be sure in both *Deep Sky #9* and Burnham's *Celestial Handbook*. Will there be any articles on unusual objects in the future? Keep up the good work!

Mark Stoicheff
302 Logan Street
Lewistown, PA 17044

Dear Mr. Stoicheff / Thank you for sharing your observation of the sky's best quasar — a tiny dot of light indistinguishable from the surrounding stars except for position. Yes, we'll run more information about unusual and obscure objects in future issues. — DJE.

The Witch Head Nebula

Dear Dave / During a recent star party at one of my darkest Arizona sites I attempted to visually detect IC 2118, the "Witch Head Nebula." This elusive object, which supposedly defines the outline of a witch's face, has never been detected visually to the best of my knowledge. I was startled to find that a faint luminous glow appeared in the region in 7x50 binoculars and decided to pursue it further.

In a 12.5-inch Newtonian at 80x it was easily seen as a dim curving strip of nebulosity occupying over two fields of view end to end. The eastern edge was sharp, with the familiar dark outline of the witch's forehead, nose, and chin plainly visible, silhouetted on the eastern side of the luminous band. The western edge, however, tapers off into the sky background.

I also noticed that with averted vision the main body of the nebula was filled with brighter lumps, dark streaks, and patches. I found this object difficult to photograph in anything but fast lens systems. Long exposures of the nebula on color film reveal an overall sky-blue color with its southern end appearing more tawny.

The brighter and more sharply defined eastern side directly faces Rigel, which seems to be a possible illuminating star for this gossamer reflection nebula.

Chris Schur
Star Route HCR Box 952
Black Canyon City, AZ 85324

Murphy's Law, Halley's Comet and the Pleiades

Sir / Murphy's Law: If anything can go wrong, it will, has a little-recognized corollary: No matter how many mistakes one makes, sooner or later everything goes right.

We are writing this letter for those who have the temerity to doubt these self-evident truths and for those who are just entering amateur astronomy. By documenting our recent experience with Murphy's Law, we hope to dispel the naive notion that optimism, experience, and luck can somehow overcome an age-old fact of human existence.

Halley's Comet reached near naked-eye brightness in mid-November 1985 and passed very close to the Pleiades, a positioning of celestial bodies that was truly unique. We participated in the Tucson Amateur Astronomy Association's Media Night on November 15. Despite a good deal of surrounding light pollution and the comings and goings of automobiles, we were able to see Halley through 4- to 12-inch telescopes. About midnight, as clouds passed in and out of the Pleiades region, DK decided to photograph the Comet.

He used a 5.5-inch Schmidt camera piggybacked on a clock-driven 8-inch Schmidt-Cassegrain telescope. Guiding was no problem, but at the end of the 10-minute exposure on hypsensitized Kodak 2415 film, a car pulled up flashing its bright lights.

We enthusiastically set out for a remote dark-sky location 60 miles southeast of Tucson on November 16. Picture this scenario: Halley's Comet and the Pleiades in the same binocular field of view, a viewing site at 5,000 feet altitude with no more than a 5° obstruction in any direction, 7th magnitude or better transparency overhead, no more than 10°-15° of light pollution on the southeastern horizon, and no clouds.

We set our scopes: JM with 6- and 12-inch f/5 reflectors for prime focus photography; DM with a 5.5-inch

Schmidt camera for wide-field photography; and TBH with 135mm and 50mm lenses mounted on a clock-driven Schmidt-Cassegrain system for piggyback photography.

First, JM broke the plug-in adaptor device to his cigarette lighter and lost all power from his van. TBH helped out with a spare part. JM then noted that the portable batteries powering his 6-inch telescope had burned out, knocking his telescope out of operation for the night. Next he managed to tear his film from the cassette holder and lost the whole roll. Fortunately we all had spare film.

TBH had no major problems. Early in the evening he properly recognized and corrected for a number of minor photographic errors: bumping the camera, taking an exposure at one second instead of on bulb, setting the lens at f/11 instead of at f/3.5, and focusing at

Dan Knauss

Comet P/Halley passes the Pleiades star cluster on November 15, 1985. A 5.5-inch f/1.65 Schmidt camera shot using hypered Tech Pan and a 10-minute exposure.

five feet instead of at infinity. Over the course of the evening he managed to take six good exposures from 5 to 40 minutes in length.

All of DK's exposures were cut short due to the continual slipping of his drive clutch — an effect of arctic conditions at the site (40°F and 3 m.p.h winds).

JM took two photos. He spent time cursing the broken plug, the ruined film, and the dead batteries, followed by clutch problems with drives on the 12-inch telescope, counterweight problems, and an image too faint to guide on. At one time near the end of a 20-minute exposure with the 12-inch telescope, the telescope tube struck one of the mount legs and ruined the exposure.

At this point we realized that Murphy's Law had prevailed. But did we quit? You bet. Besides, it had now clouded over and we had been observing for five hours. Did we manage to joke about our ill luck, sit down and relax, enjoy a cup of hot chocolate, and observe Halley through cloud breaks? Of course not. The night was growing old, we were growing cold, we had a long drive back into town, and we needed to develop our photos the next day.

Our results included DK's photo on Friday night, amidst light, car, and people pollution, which was splendid. All his photos from Saturday, at a perfect site, were ruined by drive problems.

JM had two interesting but unaesthetically pleasing photos with zigzag and square-shaped star trails. TBH's entire roll of film was blank.

To summarize, we possessed over $10,000 worth of telescopic and photographic equipment and at least fifty years of combined amateur astronomy experience, and we still could not overcome Murphy's Law. Surely this one experience proves the Law's validity. Its corollary was dramatically proven true by DK's one impossible shot and an adventure to laugh about and enjoy.

Astronomers beware. Murphy's Law exists: it operates at all times and can not be overcome. But since the corollary also works, amateur astronomy can be fun, exciting, and rewarding, despite even the most determined efforts to have a miserable time.

Tim B. Hunter
Dan Knauss
James McGaha
The University of Arizona
Department of Radiology
Tucson, AZ 87524

h & χ Persei

An In-Depth Look at Two of the Sky's Most Familiar Open Clusters

by F. Michael Witkoski

From any dark site any time of the year you can see some piece of the Milky Way, the conspicuously bright, disk-shaped part of our Galaxy that we view from within. Covering only 10 percent of the sky's area yet contributing 90 percent of its starlight, the Milky Way is a single super deep-sky object. Yet within this ring of light are many individual objects worth observing, one of the most notable being the Double Cluster in Perseus.

Lying near the bright "W" of Cassiopeia, this bright pair of star clusters appears as a double patch of fuzz rising out of the northeast to the unaided eye on an autumnal evening. While observers endlessly debate about the premier single deep-sky object, the Double Cluster is absolutely the finest pair of deep-sky objects in close proximity, their glimmering stars perched gracefully at the northern bend of the Galaxy like an eagle on a mountaintop.

The Double Cluster was one of the relatively few deep-sky objects known about before the invention of the telescope: being an easy naked-eye object, it was recorded by the Greek astronomer Hipparchus in the second century B.C. The Alexandrian astronomer and mathematician Ptolemy knew of the Double Cluster, and it certainly piqued the curiosity of many more early skywatchers.

◀

Two of the most brilliant open star clusters, NGC 869 and NGC 884, lie just a Moon's diameter apart in Perseus. Each is visible to the naked eye as a fuzzy spot in the Milky Way; when viewed with a scope, however, the objects become rich, bright clusters of stars. Photo by Jean Dragesco; 300mm f/2.8 lens, 103a-F emulsion, 20-minute exposure

During the past few centuries the Double Cluster has amassed several designations. The official identifications are NGC 869 and NGC 884, from Dreyer's *New General Catalogue*, although the earlier names h and Chi (χ) Persei, an unusual mix of a Roman and Greek letter, are nearly as common. Less often we see the references 33^{VI} and 34^{VI} from William Herschel's extensive list of telescopic objects, wherein category VI represents "very compressed rich clusters of stars." A less structured list of the finest 60 deep-sky objects visible from northern latitudes by Edward C. Pickering also includes it. Oddly, the pair is absent from the mid-18th century catalogue of 109 nebulous objects compiled primarily by the comet hunter Charles Messier. Finally, the expression "Double Cluster" itself appears to be a product of the turn of the century. One of its earliest uses appears in Kelvin McKready's 1923 work *A Beginner's Starbook*. In 1888, Garrett P. Serviss referred to the Double Cluster as a rich swarm, but with no apparent intent to christen it as such.

The Double Cluster forms a triangle with Delta (δ) and Epsilon (ε) Cassiopeiae, the two easternmost stars in the "W" of Cassiopeia. Alternatively, a chain of bright stars in Perseus points from the southeast to our clusters. Once you've found the Double for the first time, however, starhopping becomes academic. The component clusters have epoch 2000.0 coordinate of 2h 19.0m, +57° 09′ (NGC 869), and 2h 22.4m, +57° 07′ (NGC 884). From center to center, the pair is separated by 45′. The galactic coordinates are: 134.63° latitude and −3.72° longitude (NGC 869), and 135.08° latitude and −3.60° longitude (NGC 884). This places NGC 884 reasonably near the galactic anticenter of 180° latitude and 0° longitude, a point in Auriga just north of the border with Taurus.

The two clusters are very similar, although NGC 869 is slightly brighter. Through small or medium size binoculars roughly 200 stars are visible in NGC 869 and 150 in NGC 884, and instruments showing stars down to 12th magnitude will reveal 400 and 300 stars, respectively. The integrated visual magnitudes are 4.4 (869) and 4.6 (884), assuming cluster diameters of 30′ for each. When considering the total starlight contribution for an extended boundary — say 50′ — the magnitudes brighten to 3.5 and 3.6. The core magnitudes for each cluster are 5.3 and 6.1, and the brightest stars are magnitude 6.55 and 8.05.

Astronomers' knowledge of stellar evolution tells us that some of the stars in these clusters and the surrounding fields are among the intrinsically brightest in the sky. The combined mass of each cluster is about 5,000 times that of the Sun, and the combined luminosity of each is roughly 200,000 times the Sun's. At least two dozen red giant stars, all variables, reside in and around the clusters, and some show their ruddy colors when viewed with backyard telescopes.

Because of their exceedingly high luminosities, the stars in the Double Cluster must be very young. The prodigious energy required to sustain such brightness would cause any star to exhaust its supply of fuel rather quickly on a cosmic time scale. By implication, the clusters themselves are among the youngest known. Estimates of the ages of h & χ are in the low millions of years; a study done in 1966 by Rudolph Schild, then of Yerkes Observatory, yielded ages of 6.4 million years (869) and 11.5 million years (884). More recent data suggest that they may be as young as 5.6 and 3.2 million years, respectively. Whatever their exact ages, the clusters are comparative youngsters: NGC 188 in Cepheus is some 5 billion years old while the solar system is 4.6 billion years old.

From the apparent and absolute brightnesses of the cluster's component stars, we can derive distances of 2.2 kiloparsecs (869) and 2.3 kiloparsecs (884), after correcting for the substantial interstellar absorption present in their direction. At such a distance intrinsically bright stars — giants and supergiants — show up in backyard telescopes, but more typical stars like the Sun and numerous dwarfs remain invisible.

Since the clusters each have a diameter of about 25 parsecs, their separation of 100 parsecs is considerable and means they are probably not gravitationally bound. However, a 1970

study of 68 stars in both clusters using 36-inch and 84-inch telescopes at Kitt Peak could not conclusively determine whether or not the stars share the same proper motion. Also, a uniform excess of interstellar reddening for the entire region cannot be determined with accuracy because of absorption by intervening dust. The topic is debatable, but it looks like the two clusters are gravitationally independent of each other.

Since the clusters conclusively reside in the Perseus Arm of the Galaxy, structural and dimensional studies of the Milky Way independently seem to verify the distance estimates of Schild and others. From these results we find that the clusters lie within a vast array of supergiant stars, which from our perspective extend beyond the clusters' edges a few degrees in each direction. The array of stars is known as the Perseus OB 1 Association. Herein the stars' characteristics are similar to those of the clusters, so when analyzing the Double Cluster, we must carefully consider its immediate environs.

Because of its relatively high declination, the Double Cluster is visible most of the year, although it is best placed during autumn and winter at "civilized" times of the night. Away from bright lights on a moonless night, it blends spectacularly with seemingly countless stars blanketing its little wedge of the sky. Separated by a mere 45', the pair so closely approaches the threshold of naked-eye separability that it is tempting to speculate whether one can actually see two objects with the naked eye, or if the mind — backed by the knowledge that two components, in fact, exist — fools the sometimes impressionable eye.

Consider Galileo's observations of Saturn. Not knowing of the ring system, he reported that the planet had "ears" on either end. What would we see through a telescope like his? Probably ears, but we would call them rings. Similarly, the small, dim planetary nebula, M76, also in Perseus, appears either single or double, depending on one's telescope, eyepieces, eyesight, and sky conditions. Its apparent duplicity earned it two NGC numbers, 650 and 651, although it is now known to be a single object composed of two lobes symmetrical to a 16th-magnitude central star.

Regardless of whether one's eye separates the components of Double Cluster, any optical aid — including opera glasses — will. Binoculars are ideal for a start. A small pair with a wide field, say 7 x 35 or 7 x 50, will unambiguously spread the components and emphasize their absolutely dominating vantage among the surrounding scatter of stars. The price to pay for such a widefield perspective is a lack of detail, although NGC 869's slight advantage in brightness is somewhat apparent to trained eyes.

Upgrading to 11 x 80 or 20 x 80 binoculars or perhaps a small rich-field telescope, we see why. NGC 869 has a brighter, more concentrated core than its neighbor. The star density is such that the central images tend to overlap,

both visually and photographically, more so than in NGC 884. Objectively, the brightest star in NGC 869, at magnitude 6.55, is four times brighter than NGC 884's 8.05 magnitude frontrunner. If the 6.55 magnitude star did not exist, the components of the Double would be almost equally bright. Brilliant stars also abound at and beyond the clusters' edges, and since the clusters reside within a swarm of field stars, cluster residency of many stars is ambiguous.

Passing to a medium-size telescope, say 8-inches in aperture, some of the red giants begin to show their color. Surprisingly, many observers seem unaware that an instrument of this size can visually detect color in stars this faint — 9th magnitude or so. An effective aid in seeing star colors can be found in defocusing the image, which spreads out the hue. A good object for practicing this technique is Alberio, the gold-blue pair in Cygnus, both components of which are much brighter than any of the Double Cluster stars.

In the most favorable cases, large, high-quality binoculars may reveal color that a larger aperture telescope may not under adverse conditions. Practice and patience are the key words. When attempting to detect colors, it's important to *avoid* averted vision, which is so effective for seeing dim extended objects, and look directly at the star's image. With straight-ahead vision the eye's color-sensitive cones are most sensitive.

The most color-conspicuous star in and around the clusters is FZ Persei, which lies at the western edge of NGC 884 and is the westernmost of four stars forming a small diamond. AD Persei, some 12' south-southwest is half a magnitude dimmer on average (remember that the red giants are all variables) and not quite as colorful. Another red giant, SU Persei, about a degree due south of NGC 884, is a bit brighter than either FZ Per or AD Per. These three are plotted in *The AAVSO Variable Star Atlas*.

Altogether about a dozen stars in this area show some color in backyard instruments. None, however, are conspicuous in NGC 869, possibly a consequence of its younger age and the corresponding lack of time for its stars to reach this evolutionary step. Although a purist may object, comparisons between telescopic views and color astrophotos will guide one to these stars. Classical observers, among them Herschel, Smyth, Rosse, and Webb, as well as T.S. Espin, who listed nine red stars in 1892, had no help from today's photographic technology but nevertheless observed the coloration.

Remember, though, that the eye's color sensitivity does not match that of photographic film. While the eye sees a fleeting glimpse, a photographic plate accumulates light over a long period. While the peak color of our stars in question is undoubtedly red, other spectral colors are present, since all stars radiate some light at all wavelengths, and the propensity of light to mix whitens the image.

Only for a certain few stars, S Cephei and R Leporis for instance, is redness intense. This is due to carbon compounds in their outer layers, which ferociously absorb wavelengths in the blue and violet spectral region. Much different from the red giants in the Double Cluster, these stars resemble little spots of blood. "A glistening ruby among shimmering diamonds" would typify a 19th-century description of these deep-hued stars.

Mu (μ) Cephei, similar to the stars in Perseus, is probably the reddest naked-eye star visible in the northern sky, and although not nearly as intense as its neighbor S Cephei — a telescopic star ranging from 7th to 12th magnitudes — a comparison of the two illustrates color intensity differences. Also, check Betelgeuse for color and compare its naked eye impression to that of FZ or AD Persei through a telescope. The difference will not be too appreciable, all things considered.

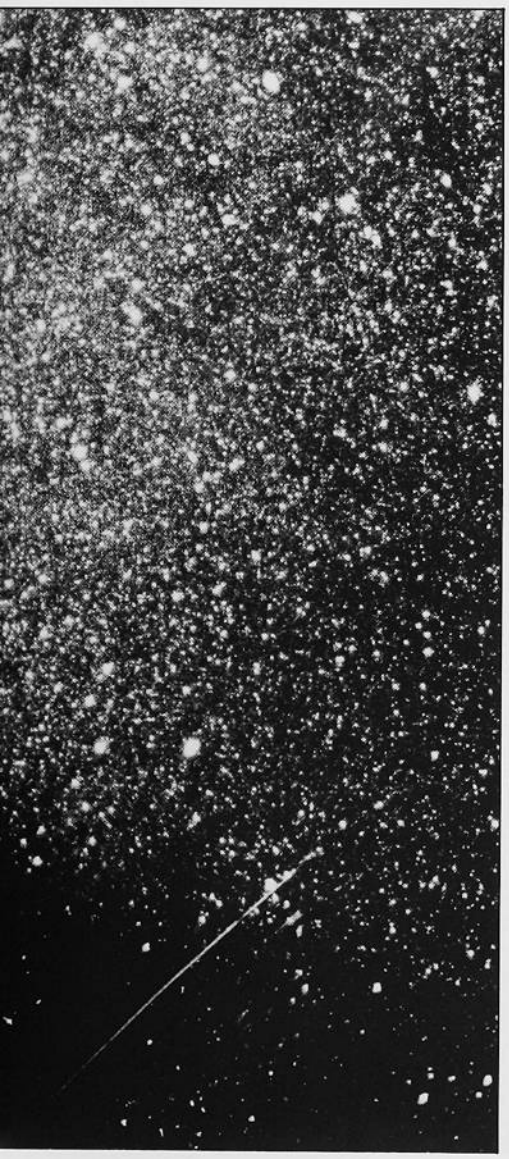
Larger telescopes, in the 12-inch to 17-inch class, are excellent probes of the clusters' cores, since they sharpen the images of the stars in proportion to their apertures. The price of a large mirror is a narrower field of view, something which a wide-field eyepiece can partially compensate for. However, for the Double Cluster binoculars and large telescopes nicely complement each other. Where the former gives an overall picture of the region, the latter can detail the close-up structure.

The managably countable number of stars in and around the Double Cluster and the bonus offered by the red giants allows large telescope users to examine the region in detail more so than with other classes of deep-sky objects. A globular cluster typically contains hundreds of thousands of stars, while galaxies and nebulae are unresolvable completely. In the Double Cluster one sees the individual pinpoints of light under almost any clear sky. Where extended objects suffer from city lights or moonglow, the stars and their colors shine through. We can investigate, and within a reasonable margin of error, answer, how many stars are actually visible through a given aperture, and with a given eyepiece.

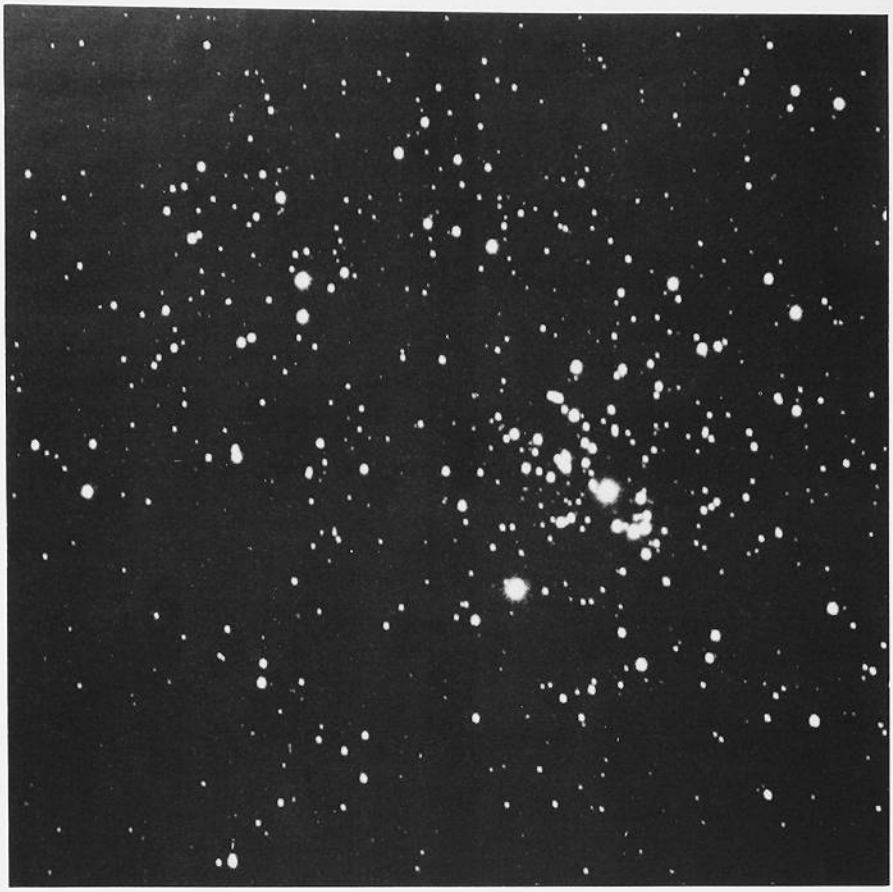
With respect to humans, stars and constellations appear absolutely timeless. As we peer high above our towns and cities, we see the same patterns which earliest civilized man pondered thousands of years ago. In what is otherwise an unstable world, the sky has always been comfortingly regular. Even the youngest of celestial denizens, such as the Double Cluster, remain virtually unaltered since the beginning of recorded history.

Nevertheless on a much finer level, definite changes occur. All stars we see move about the center of the Galaxy at differing, albeit barely perceptible speeds, and many vary in light output while they orbit. The study of variable stars is one of our most powerful astronomical tools. Sometimes a star will fluctuate by several magnitudes, sometimes by only a few hundredths of a magnitude, each magnitude representing 2.512 times more light than the next dimmest magnitude.

How do astronomers measure the



◀ *The Double Cluster rises over treetops in this 6-minute exposure on 103a-E film made with a 50mm f/1.8 lens. The constellation Perseus lies at lower left, Cassiopeia at upper right, and two meteors left their signature during the exposure. Because it is bright, the Double Cluster is relatively easy to photograph. Photo by David Healy.*



▲ *NGC 884, also known as χ Persei, is slightly larger than its companion but contains fewer stars and is slightly dimmer. It is nonetheless fascinating when viewed with a telescope because of the many colored stars within its boundaries. Photo by Howard F. Zeh; 14-inch f/10 SCT, 103a-E film, 30-minute exposure.*

▼ *The Double Cluster is an ideal deep-sky object for observers with binoculars. It offers a field rich with colorful stars, is bright enough to be impressive in small binoculars, and is above the horizon frequently in the Northern Hemisphere. Photo by Robert Reeves.*

brightness changes of variable stars? Measurement of light intensity — photometry — is accomplished by 1) visual, 2) photographic, and 3) photoelectric methods. Visual photometry is the comparison by eye of a subject star with one of a known magnitude. Under the best circumstances an experienced observer can detect differences as small as one-tenth of a magnitude. Because of possibilities of human error, compounded by atmospheric and sky conditions, the reliability of visual photometry is severely limited.

Photographic photometry, while providing a tangible copy of an observation, has several drawbacks. The most serious is its incompatibility with visual observations; the photographic plate is most sensitive to blue and violet light, while the eye is most sensitive to yellow light.

Photoelectric photometry measures actual photons of light without the inherent problems the eye or photographic plate are subject to. Impulses are gathered electronically and converted to objective digital readouts. Photoelectric photometry is accurate to within a few hundredths of a magnitude and is far more effective than visual or photographic photometry in the study of variable stars.

Several mechanisms cause stars to fluctuate in brightness. In some cases close components of a double star eclipse each other with the resulting variation being due only to the stars' geometry relative to our line of sight. The best-known eclipsing variable is in Perseus. It is Algol, sometimes called

the "Demon Star," a label which attests to the fear man once held toward change in the firmament.

In other cases the stars vary intrinsically, sometimes with clocklike regularity, sometimes semiregularly, and sometimes suddenly, or at best, unpredictably. Steady pulsations account for most regular variations, while the majority of unpredictable changes result from more violent occurences. Novae and supernovae are the two most dramatic types of variable stars.

The best known regularly pulsating star is Delta (δ) Cephei, prototype of a class of yellow stars (spectral type F5 to G3, approximately) known as Cepheids. They exhibit a definitive relationship between their period and intrinsic luminosity. Typically they vary by about a magnitude every few days. From their observed periods and their consequent known actual brightness, their distances are easily calculated, and by association, distances of clusters or galaxies where they reside can be determined. Some line-of-sight Cepheids reside in the Double Cluster region. The brightest is VX Persei, which varies from magnitude 8.98 to magnitude 9.70. Although the star itself is an easy target, its color is not detectable visually.

Similar to the Cepheids are Beta(β) Cepheids, luminous white (spectral type B1 to B3) stars which vary a small amount in a very regular, but short period. They are photoelectric objects, and several appear on the accompanying list of variables for the Double Cluster region.

The variables in the region most relevant to backyard observing are red supergiants. All are seemingly similar to Betelgeuse, whose variation ranges from about 0.4 to 1.3 and is conspicuous to most naked eye observers. The variability is primarily driven by pulsations, but the period is not regular, and superimposed periods seem apparent. The same is undoubtedly true for most of the red stars in the Double Cluster. Published periods for many of the stars are not based on conclusive or detailed studies. This compounds what uncertainty may arise from their already irregular periods. Apparently, visual observations supply what little data is currently available.

To resolve discrepancies and to fill gaps would require photoelectric monitoring for years or decades. Because the candidate stars are presumably irregular, visual observations would necessarily be imprecise, not only because of the inability to detect subtle variations possible superimposing periods would cause, but also because no reliable comparison stars would be available. All the red stars would vary, of course, and different eyes would interpret red light from the subject stars versus the white light from the comparison stars differently.

Since professional equipment is being used on objects much fainter than Perseus supergiants, the door is wide open for amateur contributions to observing the Double Cluster stars. Although an investment in photoelectric equipment would be necessary, the dividends would pour in. After you have located and maybe marvelled at the subtle, but definitely ruddy pinpoints of light, you can closely and continuously monitor one or more and make an important contribution to astronomy.

At least one star in the region, S Persei, is being monitored by Brian Skiff of Lowell Observatory, but dozens of others need to be looked at. To help get started, you may contact either the American Association of Variable Star Observers (AAVSO), 25 Birch Street, Cambridge, Massachusetts, 02138, or the International Amateur-Professional Photoelectric Photometry (IAPPP) organization, Dyer Observatory, Vanderbilt University, Nashville, Tennessee, 37235.

Whereas the variable stars in the Perseus region offer much to the observer, the double stars are utterly uninspiring. There are no close, bright pairs, and the sheer density of stars quickly diverts any attention from a pair, which in isolation would otherwise be a fine double. After all, what is the difference between a field of several hundred stars and several hundred plus two stars? We can rationalize by saying that when we have a pair of splendid, dazzling clusters, who needs two more stars?

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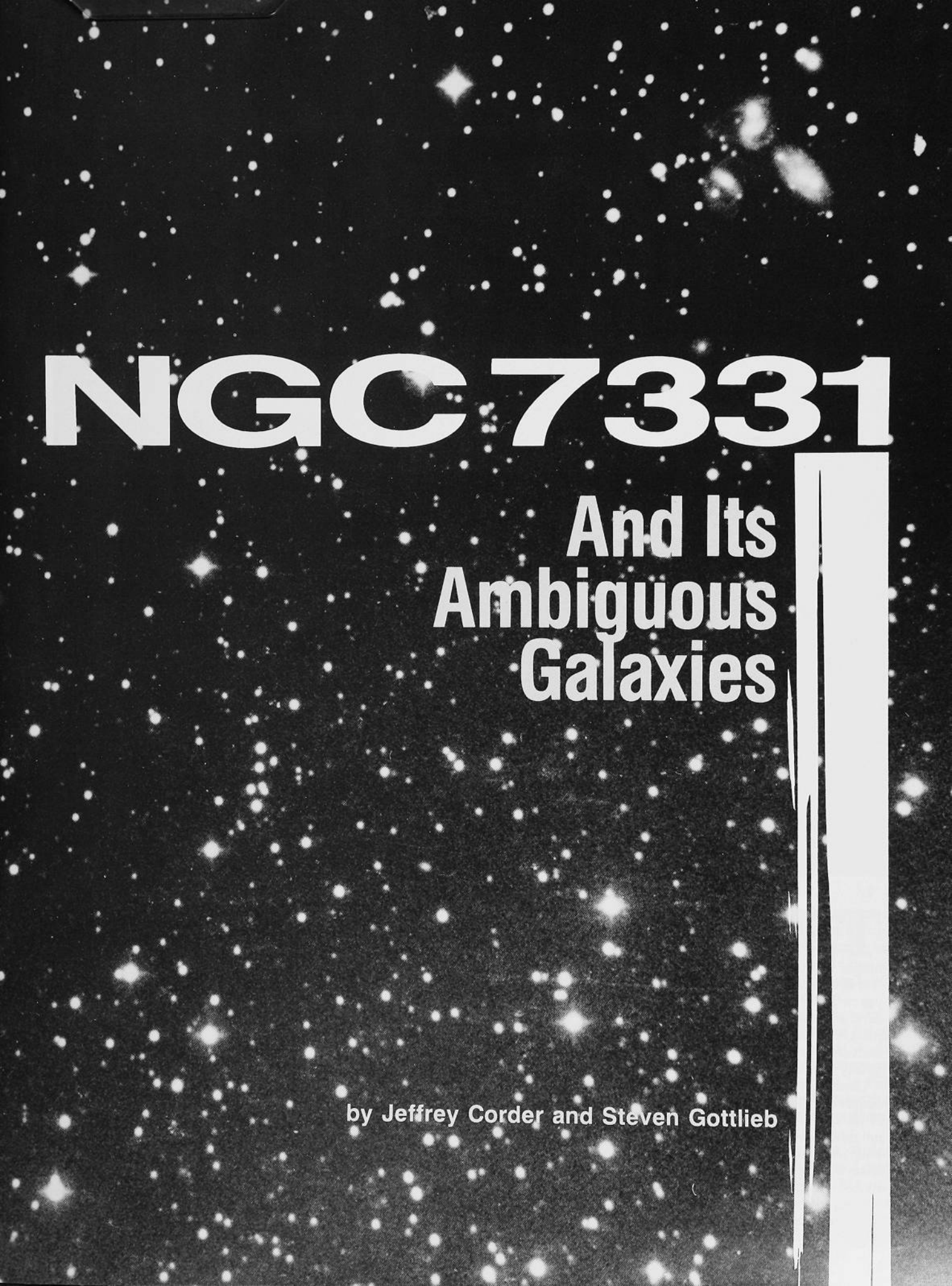
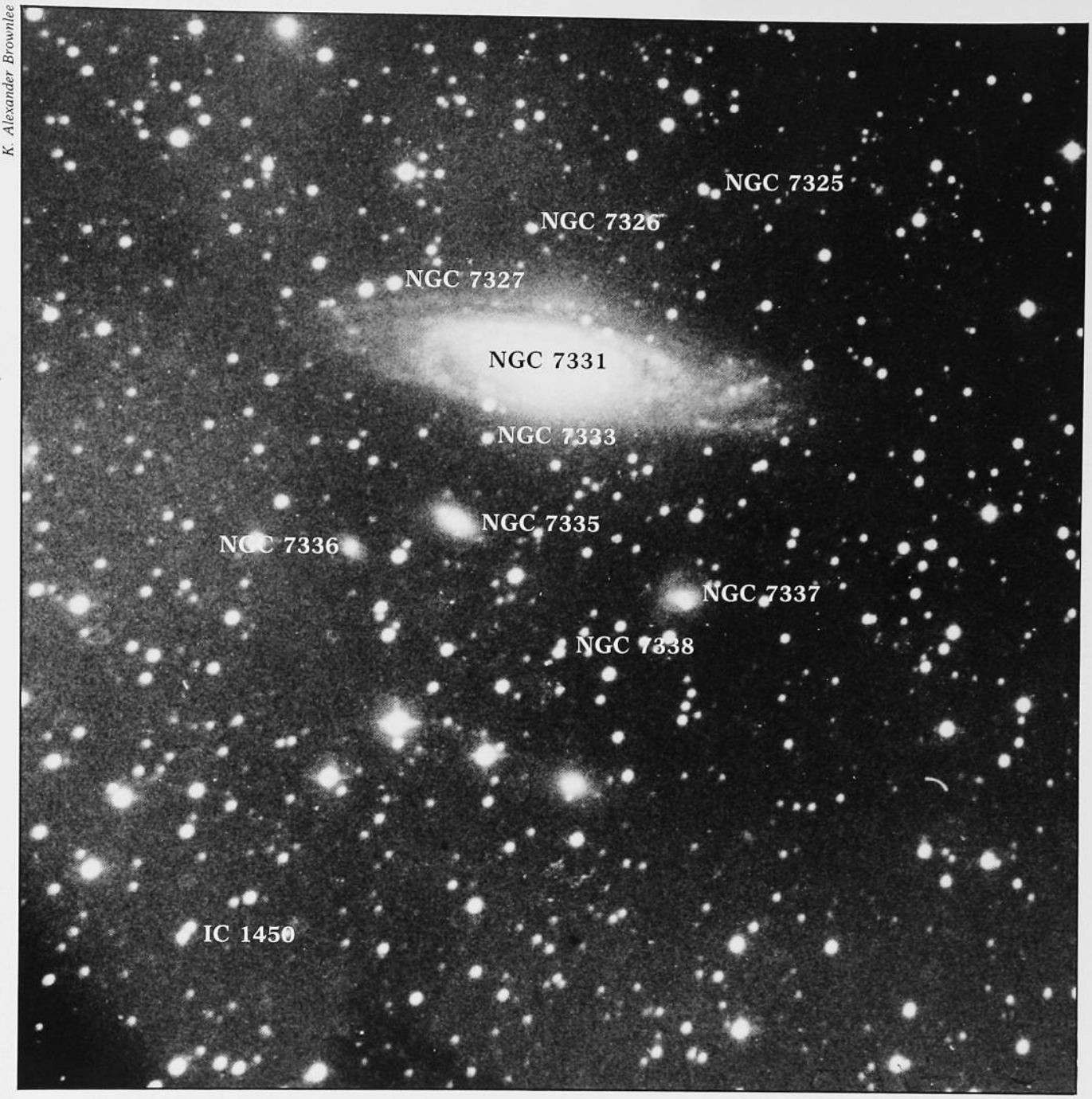
Variables in the Double Cluster

ID	RA (1999.9986) DEC	Variable Type	Mag. Range	Period(s) (days)	MK Type	HD #
V351 Per	2h 9m25.824s 56°59'46.93"	β Cep?	8.69-8.72V	1.3746	B1III	13057
KK Per	2h10m15.698s 56°33'31.08"	Lc	(6.6V)-7.78V	—	M2Iab	31136
UX Per	2h13m 7.214s 58° 4'48.14"	δ Cep	11.89-13.32B	4.56581	FS-G3 (I)	— background object
V352 Per	2h13m38.222s 56°33'57.48"	β Cep?	9.47-9.49B	0.21995	B1III	—
* V355 Per	2h16m 5.002s 57°44'16.15"	E?	9.05-0.09V	0.7074	B3IV	13758
V356 Per	2h16m58.037s 57° 7'47.83"	β Cep	9.29-9.32B	0.30595	B1III	—
* V357 Per	2h16m57.287s 56°43' 5.82"	β Cep	7.67-7.70B	0.28619:	b2Ib	13866
PP Per	2h17m 8.386s 58°31'47.25"	Lc	9.2-10.3V	—	M0.0Iab-M1.5Ib	—
V358 Per	2h17m 7.629s 56°46'11.00"	β Cep?	8.52-8.61V	1.241:	B1III pe	13890
BU Per	2h18m53.738s 57°25'14.60"	SRc	10.4-12.3p	365:+2950	M4Ib	—
* T Per	2h19m22.183s 58°57'42.60"	SRc	8.2-9.1Vv	260:+326+2800	M2Iab	14142
* V359 Per	2h20m14.313s 57° 5'44.02"	RC?	9.27-9.30B	0.27500	B1III or B1IV	14250
AD Per	2h20m29.050s 56°59'36.80"	SRc	10.0-10.8p	320	M2.5Iab	14270
FZ Per	2h20m59.136s 57° 9'28.37"	Lc	9.5-10.5p	184	M1VIab	14330
* PR Per	2h21m42.848s 57°51'48.92"	Lc	9.8-10.8p	—	K5eIb-M2-Ib	14404
* SU Per	2h22m 6.551s 56°36'16.74"	SRc	9.3-10.5p	470	M3.5Iab	14469
* RS Per	2h22m23.962s 57° 6'33.40"	SRc	10.1-12.4B	—	M4Iab-Ib	14488
V360 Per	2h22m48.045s 57°30'31.48"	β Cep?	9.85-9.88B	0.20072?	B1III	—
* S Per	2h22m52.128s 58°35'13.36"	SRc	7.9-11.5V	see note	M5eIa	14528
V361 Per	2h23m35.499s 56°34'39.38"	γ Cas	9.73-9.64V	—	B1.5IIIe	14605

*: V355: typical V~9.30; V357: typical V~7.50; T Per: typical V~8.5; V359: typical V~8.96; PR Per: typical V~7.8; SU Per: typical V~7.6; RS Per: typical V~8.3; S Per: several similar double-periods suggested: 810+916 days, 807+968, 825+940, OH and H_20 in emission.

The field of NGC 7331 is shown here in this photo by K. A. Brownlee. The three galaxies to the east of 7331 are NGC 7335, 7336, and 7337. All other noted objects are stars or close double stars.


NGC7331
And Its Ambiguous Galaxies
by Jeffrey Corder and Steven Gottlieb



The brightest galaxy in Pegasus, NGC 7331, lies high overhead for northern viewers on fall evenings. This spiral was one of William Herschel's earliest discoveries over 200 years ago. Since then, it has been carefully studied by astronomers using progressively more sophisticated instruments and today is considered a galaxy much like our own Milky Way.

Classed as "spiral nebulae" by early observers, galaxies, they noticed, are often accompanied by smaller, fainter neighbors. NGC 7331 is no exception. Following Herschel's discovery, various observers noted the presence of eight suspected companions. Modern observations support the likelihood of a true galaxy cluster in the background, but NGC 7331 is probably not involved. Chance alignment has the galaxy in the foreground along the same line-of-sight as the small, more distant group.

Discoveries of new galaxy companions were often a pathway to fame and success for late 18th- and early 19th-century astronomers. Monstrous-size telescopes employed by these observers were able to reveal innumerable small "nebulae," but were cumbersome to use, making the note-taking process difficult and drawn-out. Errors were inevitable. Moreover, the telescopes were often situated in locations subject to extended spells of bad weather. Astronomers therefore found it difficult to recheck their notes and observations. The NGC 7331 group fell victim to these errors, some of which have been passed down to more modern times.

Although visible in large finder scopes, NGC 7331 was apparently missed by Messier. In many respects this galaxy resembles the famous Andromeda spiral. Like M31, the Pegasus galaxy is much elongated. This appearance is caused by its nearly edge-on alignment. It has been determined that the western side is nearer to us, hence the galaxy is believed to be rotating with the spiral arms trailing. Lying 23 times more distant than M31, and with an angular size one-twentieth that of the nearer galaxy, it can be seen that NGC 7331 is comparable in size. Also, like M31, 7331 is rich in HII regions; over 125 have been catalogued. These clumps of ionized hydrogen allow 7331's mass, rotation, and distance to be measured with accuracy. The main

Table One

NGC	DISCOVERER	R.A.	DEC.	NOTES	REF.
7325	Schultz 1882	22h 35.7m	+34°15′	"F,vS,7331 foll."	1,3,4
7326	Rosse, 1874	22h 35.7m	+34°18′	"eF,eS,7331 foll."	3,1
7327	Tempel	22h 35.7m	+34°21′	"eF,eS,Np 7331"	5,1
7331	W. Herschel	22h 35.9m	+34°18′	"B,pL,pmE 163°,smBm"	1,3,4
7333	Schultz, 1882	22h 36.1m	+34°19′	"VF,VS,p 7335"	1,3,4
7335	W. Herschel	22h 36.1m	+34°19′	"VF,VS,pos 61°,dist 228″"	1,3,4
7336	Rosse, 1849	22h 36.1m	+34°21′	"eF,VS,pos 43°,dist 315″"	1,3,4
7337	Rosse, 1849	22h 36.3m	+34°15′	"eF,S,Stell,p119°d328″"	1,3,4
7338	Tempel	22h 36.3m	+34°18′	"eF,eS,Sf 7335"	5,1
7340	Rosse, 1849	22h 36.5m	+34°18′	"VF,VS,pos 92°,dist 507″"	1,3,4

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difference between M31 and 7331 is the greater abundance of younger, bluer stars in the Pegasus galaxy.

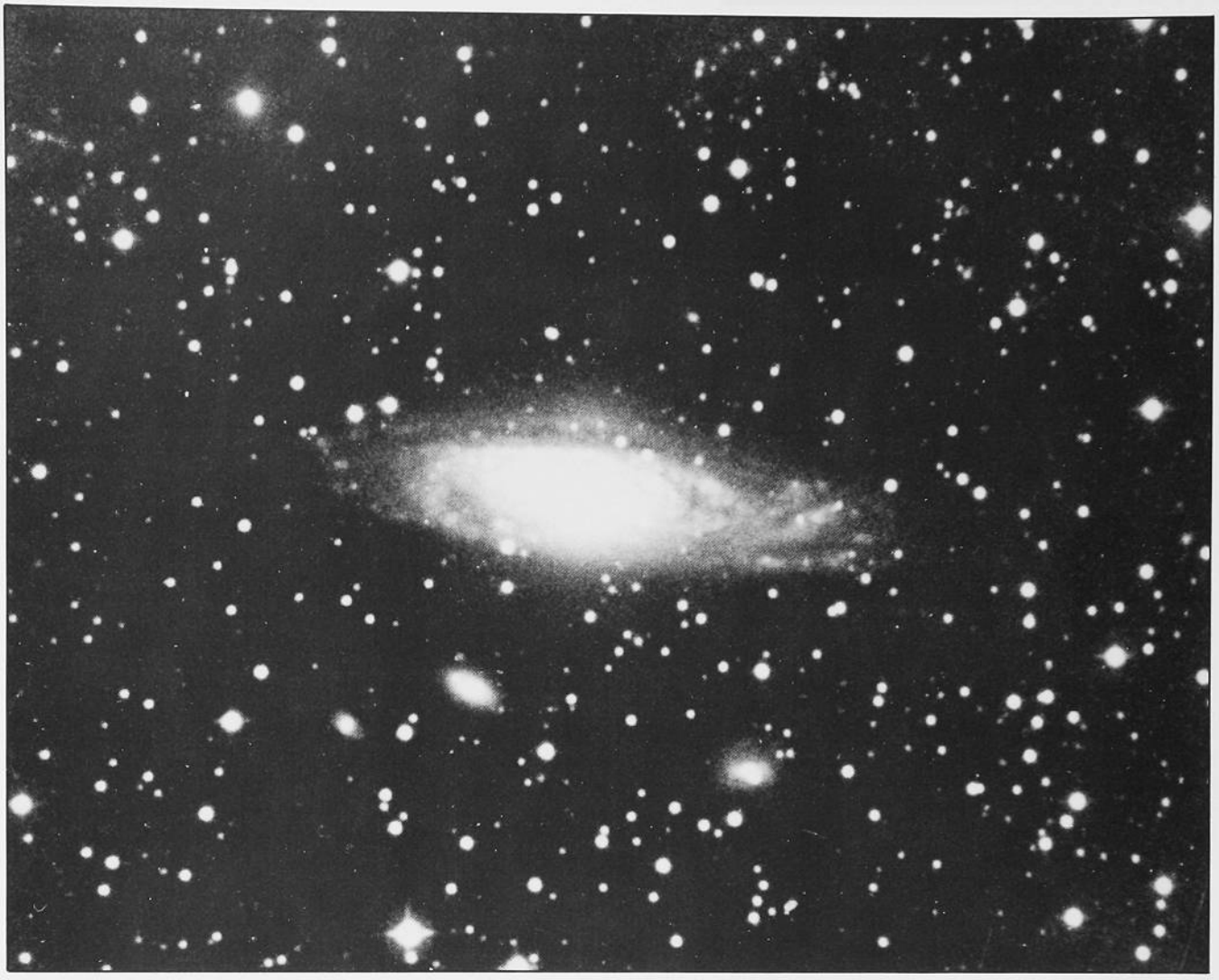
Recently, sources of radio emission have been observed in the region of NGC 7331. The sources also seem to engulf the nearby galaxy cluster, Stephan's Quintet, located about 1.5° to the southwest. This, along with the photographic evidence of a very faint but extensive filament of material stretching between Stephan's Quintet and NGC 7331, argues for a past gravitational interaction that may have once occurred between these galaxies. NGC 7320, the largest member of the Quintet, lies in the foreground of its more distant members, and is the most likely candidate for an ancient association with NGC 7331.

Observers with small telescopes can easily view the prominent features of NGC 7331. It has a well-defined oblong core, and a bright, compact nucleus. The north-south orientation is also quite plain. Spiral structure is evident in 12-inch and larger telescopes. Remarkably, some of the associated HII regions can be seen in larger instruments, especially of the 16-inch class. Careful observers with large telescopes, keen eyesight, and dark skies may catch glimpses of the string of HII knots aligned along the western edge of the galaxy. As with M31, a dust lane is visible.

As noted in the first table, a total of nine NGC entries lie in the vicinity, including NGC 7331. A second table includes five questionable NGC entries, with their RNGC coordinates and descriptions. Again, although the galaxies listed in the tables seem to be companions of NGC 7331, even a casual inspection of photographs reveals NGC 7331 to be a foreground object.

Observers using 8-inch telescopes can see only a couple of the galaxies listed in the first table, partly due to their dimness, but also because of the many ambiguous galaxies catalogued in this region. Let's explore the entries for the NGC 7331 region in historical detail and find the true members.

A comparison of the two tables reveals a discrepancy in positional data for the first two entries, NGC 7325 and NGC 7326. Both objects were studied by Lord Rosse and other Irish observers at Birr Castle in 1874. Accurate



K. Alexander Brownlee

positions were measured in reference to NGC 7331 and it is clear that the original observers mistook the slightly elongated appearance of close double stars for very small galaxies. The authors of the RNGC evidently used these two ambiguous NGC designations to incorrectly label two nearby anonymous systems, both 10′ northwest of the original NGC positions.

In actuality, NGC 7326 is a close pair of magnitude 15 stars just west of the core of NGC 7331, and NGC 7325 is a wider double easily resolvable in a 10-inch scope, 3′ south. It is likely that poor resolution of the older telescopes, compared to even the common smaller compound telescopes of today, misled the earlier astronomers into making such false discoveries as these two "galaxies." The newer RNGC 7326 is listed in Fritz Zwicky's *Catalog of Galaxies and Clusters of Galaxies* (CGCG) as 514.066 at photographic magnitude 15.7 and is visible in backyard scopes.

The next object, NGC 7327, was discovered by the German astronomer Ernst W. Tempel with an 11-inch refractor. Although Tempel gave only a vague position in his original paper, Dreyer gave an exact position in the NGC that closely matches Tempel's description of "preceding the northern end of NGC 7331." This information was undoubtedly conveyed through private correspondence. No double star is noted at the exact position from the NGC, but a single faint star lies very near the expected position. Astronomer Harold Corwin, Jr. of the University of Texas at Austin believes that some of the nebulosity involved with NGC 7331 may have caused the star to appear nonstellar to early observers, but he is guarded in his opinion. A visual inspection of the star in question shows not the slightest hint of nebulosity. It is likely that Tempel was misled during a period of poor seeing. Since Tempel claims to have seen all nine "nebulae" in this region it is also assumed this could not be a duplicate of another of his observations. We may never know exactly which object Tempel actually saw, but it is plain that no galaxy exists at the given NGC position.

Our next object, NGC 7333, was discovered by Dr. Herman Schultz at Uppsala, Sweden and announced in January 1875. Fortunately, Dr. Schultz gave a precise position for his new "nova" to the east of NGC 7331. The astronomers at Birr Castle, using their tremendous 72-inch reflector did not find the Schultz object, which right away cast doubt on its existence. Modern telescopes show an extremely close double star at that location, which is just elongated on a Hale 5-meter plate. Amazingly, Schultz must have noted this elongation visually in his 13-foot focal length refractor. The exact match in position leaves little doubt as to the certainty of the identification. The RNGC correctly notes this as a double star.

NGC 7335 is one of the galaxies that does indeed exist. Discovered by William Herschel, this galaxy is the brightest of the group of four on the eastern side of NGC 7331. It lies in Herschel's class III, "very faint nebulae." Because of its great distance only photographs reveal much detail, but observers will note its distinctly enlongated shape and large bright core.

The other three galaxies positioned on the eastern side of NGC 7331 can be seen in 10-inch or larger telescopes. One of these is a nearby companion to NGC 7335, the barred spiral NGC 7336 only 2′ north-northeast. This system was discovered by Lord Rosse but seems to

Table Two

RNGC	R.A.	DEC.	RNGC DESCRIPTION	CONCLUSION
7325	22h 35.4m	+34°22′	"R,alm stel,HISB	not NGC object,10′NW
7326	22h 35.3m	+34°25′	"EL,sldiff,BM,sstsusp	not NGC object,10′NW
7327	22h 35.7m	+34°21′	"*"-Carlson	star NW 7331
7333	22h 36.1m	+34°19′	"**"-Carlson	close double NNW 7331
7338	22h 36.3m	+34°18′	"**"-Carlson	double star NNE 7337

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3. Carlson, Dorothy. "Some Corrections to Dreyer's Catalogue of Nebulae and Clusters." *Astrophysical Journal* 91 (1940): 350.
4. *Publications of the Lick Observatory. Vol. 3.* Sacramento: University of California Publications, 1918.

Also: private correspondence with Dr. Harold Corwin, Jr., The University of Texas at Austin, Astronomy Dept. RLM 15.308. Austin, TX 78712, 12 Sept. 1985.

have been missed by Zwicky in the CGCG. Otherwise, all of the early observers seem to have their identifications correct in this case. Visually NGC 7336 is very faint and elongated in a northeast-to-southwest direction. It appears very small and contains a bright core. Although the faintest of four galaxies in this group, it should present no challenge to a 17.5-inch telescope.

The third small galaxy that can be viewed in backyard telescopes is NGC 7337, again discovered by Lord Rosse. This barred-spiral system is located about 7′ south of the NGC 7335/36 duo. A 13th-magnitude star appears nearly attached on its southeast side. The galaxy is very faint, very small, and round, and has an even surface brightness. Brighter NGC 7340 is just to the northeast.

The second of Temple's two "discoveries" in this area has been catalogued as NGC 7338. Only vaguely referred to in Tempel's original paper, it is noted as being "between the four brighter nebulae to the east, a little closer to the two southern ones." We can only assume that he was able to satisfy Dreyer with a more precise location, than which appears in the NGC. This time the NGC position does not fall on any visible star, double star, or galaxy. Corwin believes the best evidence points to a faint double star 3′ southeast of NGC 7335. This position differs with the NGC position by only 0.2′ of right ascension. The NGC position may be off by this much, as it seems then to fit Tempel's original notes more accurately. At any rate, a visual inspection of the star in question shows it to be double, which could be mistaken for a nearly stellar galaxy.

The final galaxy for consideration in the NGC 7331 area is NGC 7340, a faint elongated system 8′ to the east of NGC 7331. The galaxy was the third and final discovery by Lord Rosse at Birr Castle, Ireland, in 1849. This galaxy is considerably faint, at only photographic magnitude 14.9, which places it as second brightest among its three faint companions. It appears round with a small bright core. This galaxy is at the very limits of an 8-inch telescope under a dark sky.

From our considerations of the field surrounding NGC 7331, it is obvious that early astronomers realized that these "nebulae" often appear in groups. Observers evidently searched the area around the brighter galaxies quite carefully, hoping to make a discovery of their own. A good example of this method is illustrated in the catalogue of the astronomers using the 72-inch telescope at Birr Castle. Even Dreyer noted that the Birr Castle "discoveries" were usually found clustered together around brighter galaxies. In our case, in the vicinity of NGC 7331, early observers correctly identified four neighbors (NGC 7335, 7336, 7337, and 7340), but mistakenly observed five others.

It is also evident from this one case that many errors still exist in the catalogues used regularly by amateurs. It is important to spend some time to research observations so that we can be certain of what we are seeing and recording. This requires some effort but it can make the difference between accurate and inaccurate observations.

Jeffrey Corder is a deep-sky observer living near Fort Meyers, Florida. His last article, "Observing the IC 4329 Galaxy Group," appeared in Deep Sky *#14. Steven Gottlieb is an avid deep-sky observer living in El Cerrito, California.*

SUMMER STARS SPARKLE

Amateur gatherings from Texas to Vermont provide a warm, wet, and wonderful way to share astronomy in the summer of '86 . . .

Texas Star Party

Fort Davis, Texas

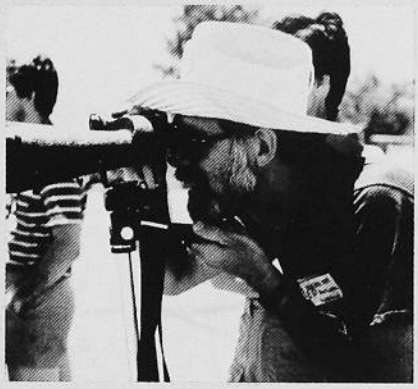
It's the morning of Monday, May 5, 1986. I leave Flagstaff to pick up Dave Eicher in Tucson, where he's spent the previous night at David Levy's house. As I drive I ponder the Arizona legislature's debate about an end to the 55 m.p.h. law, noticing that drivers have already repealed it. Upon arriving in Tucson I meet Dave, David Levy, and Steve Larson at the University of Arizona's Lunar and Planetary Lab. We go to lunch at a Chinese place and talk comets. Dave, fresh from a night of observing in David's semi-dark backyard, is primed for the black Texas sky. We leave David, who will meet us in Texas a few days later, and spend the rest of the day driving through the blistering heat to Portal, Arizona, where we stay with friends. We spend the evening hours on a rooftop deck staring at the exquisite sky over the Chiricauha Mountains, whose pinnacles tower most of a mile above the house. Halley's Comet is exactly comparable to M35, a fairly faint (magnitude 5.0) naked-eye fuzz. Sporadic meteors of 4th magnitude and fainter occur at a rate of 100 per hour. Later, wind off the summit drives us indoors to sleep for the next day's journey.

Tuesday is another long, hot haul which ended as we pulled into Fort Davis to meet Mike Dennis of the Oklahoma City group and also Chairman of the TSP, and his friend fellow Oklahoman, David Higgins. At the commercial vendors area I talk to Jack Marling, Biff Bigbie, and others. The telescope fields are dotted with telescopes of every type — 16- and 20-inchers are strewn everywhere. Everyone is dehydrated from the heat, and the humidity is reported to be only 3%.

Wednesday, Thursday, and Friday bring photometric skies for great viewing, although dusty air scatters starlight and the zodiacal light is nearly blinding. Chris Allen's telescope and Varo image intensifier provide interesting views of NGC 2610, NGC 3521, Abell 2151, the Norma star cloud, the Owl Nebula's central star, and some forty galaxies in the central ½° of the Coma cluster. Shadow-casting fireballs light the grounds on all three nights, causing "oohs," 'aahs," and scattered applause across the fields. Comet Halley outbursts on Friday evening to magnitude 4.0 and appears bigger and brighter than during the previous two days. Another common sight is NGC 5128, sporting a magnitude 12.5 supernova that was discovered by the Rev. Robert Evans in Australia just one week before.

On Saturday, May 10, Dave and I walk around and talk to many amateur astronomers about their telescopes and observing. (The two of us and Jack Marling had given a talk about deep-sky observing a couple of nights before, and we were delightfully surprised at the large number of faint objects amateurs

knew about.) David Levy had arrived the night before, and *Sky and Telescope*'s Steve O'Meara appeared Saturday afternoon. On Saturday night I dined with Dave, David, Steve, Ed Boutwell, George Ellis, and others before hearing O'Meara's controversial rundown of his Halley sighting at 19th magnitude. Afterward we had the final half-night of viewing before cirrus moved in. Could David Levy have found Comet Machholz the next morning if he had stayed up? *Brian Skiff.*



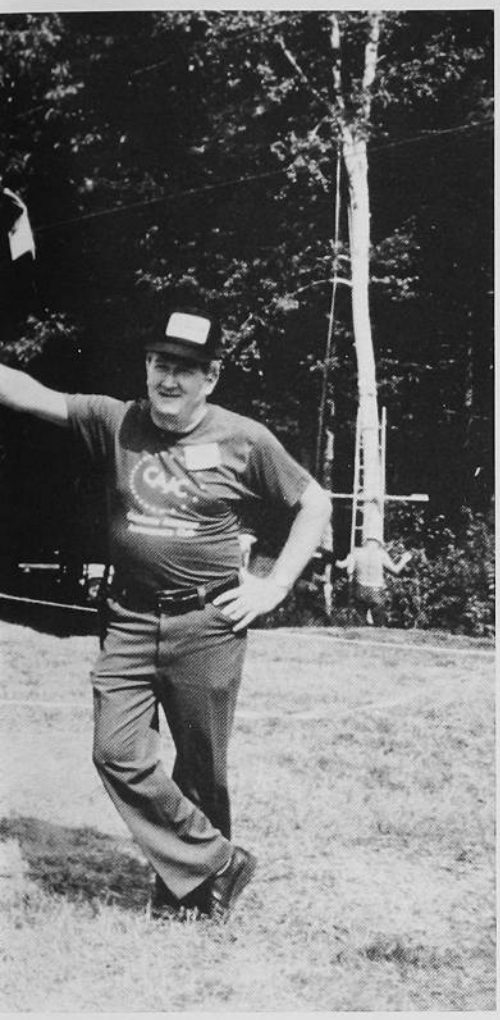
▲ *McDonald Observatory's 82-inch Otto Struve reflector towers over University of Texas astronomers standing on the dome's floor. Years ago the telescope's mirror was cracked from pistol shots fired by a deranged graduate student, but the reflector's performance is now nearly normal. Photos in this article are by D. Eicher, B. Skiff, and M. Witkoski.*

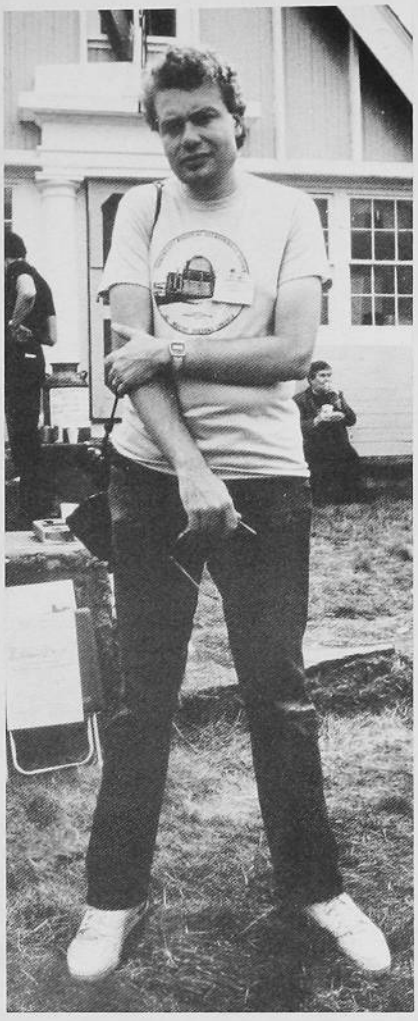
◀ *Alabamian Ed Boutwell uses binoculars to survey his observatory near the Prude Ranch from the summit of Mount Locke.*

A daytime view of the upper field at the Texas Star Party shows concern for the fierce, dusty breezes — everything is weighted down and wrapped in plastic. At night, though, screams of joy rocked the Ranch as amateurs picked out galaxies and planets.

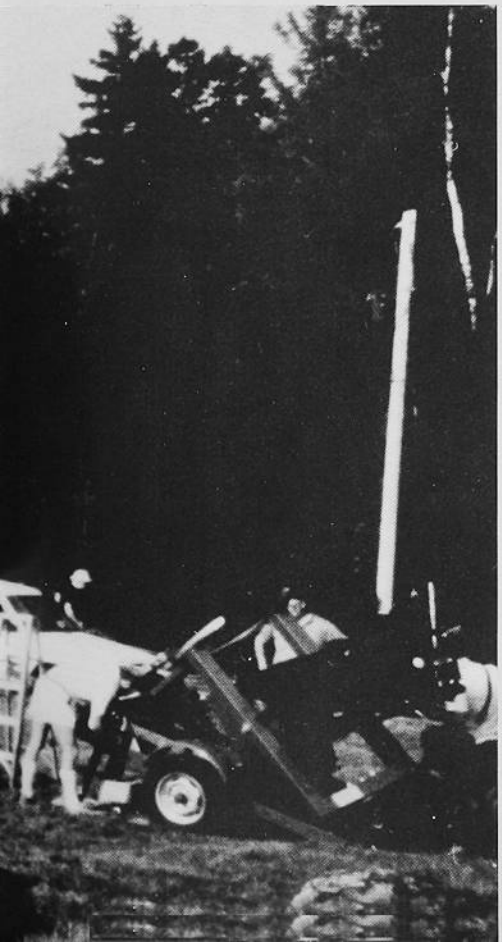
▶
The most impressive scope on Breezy Hill this year was Gayle Riggsbee's massive 17.5-inch f/4.5 trailer-mounted Newtonian.

▼
Carl Lancaster stands with his radio-controlled 10-inch f/6 scope.





▲ *Frequent* **Deep Sky** *contributor Phil Harrington stands on the hill for a snapshot.*



◀ *As Stellafane 1986 winds down, observers disassemble telescopes, get ready for long drives and plane flights, and try to forget the drenching rains that characterized this fiftieth convention year.*

Stellafane

Springfield, Vermont

When I left Mitchell International Airport in Milwaukee on July 31, the sky was deep blue and the temperature disturbingly warm. By the time the 727 shuttle touched down at Chicago's O'Hare Field and I stepped off the plane to meet David Levy, I'd accepted the fact that this would be a warm, sticky trip. After sitting for quite some time on the ground, our American DC-10 finally taxied out and headed for Boston's Logan International Airport.

David and I arrived in Boston after dark and immediately claimed our rented car — an unfamiliar place seems vaguely hospitable if you have transportation. We drove around the city, eventually settling on a place to stay before the long drive the next day.

The drive from Boston, Massachusetts, to Springfield, Vermont, is relatively slow-paced and pleasant. Routes 2 and 2A — small, intertwining highways — spread from Boston to Cambridge, home of Harvard University and the Massachusetts Institute of Technology; from Cambridge to Lexington and Concord, famous from the annals of history; and on to Greenfield, which carries traffic northward to Springfield, Vermont. The journey takes just over three hours.

Arriving at Stellafane the afternoon of August 1, David and I surveyed Stellafane's famous pink clubhouse, walked around, and talked to amateurs from all over the country and Canada. Breezy Hill soon began to fill and, as the evening progressed, the electric feeling of being in an historic place surrounded by people with a similar interest grew.

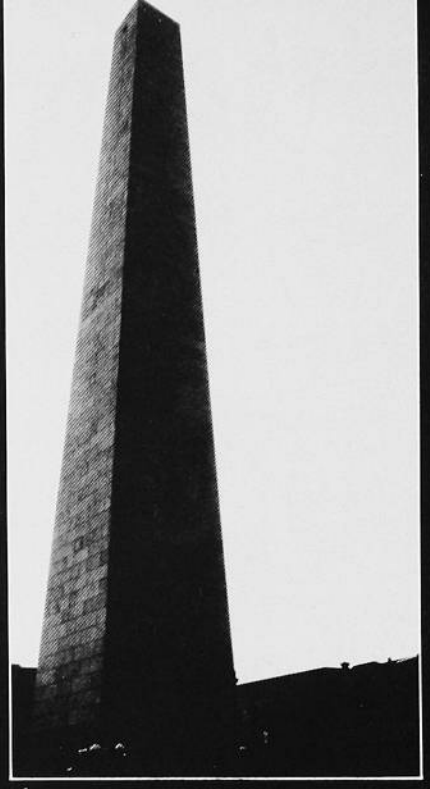
A variety of interesting telescopes sprang up on the Hill, including an imposing steel trailer-mounted scope built and owned by Gayle Riggsbee of Charlotte, North Carolina. The scope uses 17.5-inch f/4.5 Coulter optics, rings made from junked tire-recapping machines, an old microscope focuser, and removable sections for transporting the telescope's glass parts safely.

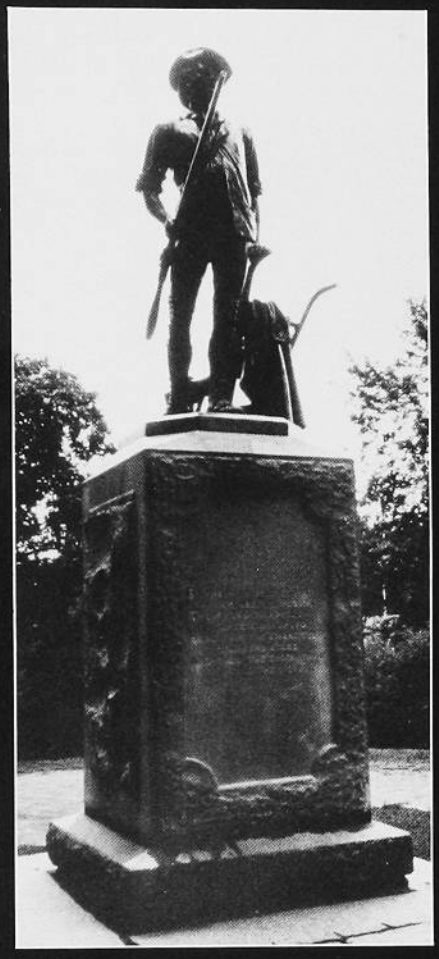
Carl Lancaster of Riverside, Connecticut, brought the 10-inch f/6 portable scope he made from a great mix of materials. The scope's oddest feature is radio-controlled focusing and pointing, made from the guts of a Radio Shack radio-controlled toy car. "I bought one, tore it apart, and along with a 3-volt motor, 6-volt lantern battery, several switches, and a voltage regulator, made a radio-controlled scope," Carl stated proudly.

Active deep-sky observers showed up in droves. One of the most notable personalities was Phil Harrington, a longtime *Deep Sky* contributor who regularly writes constellation features.

text continues on page 26 . . .

▶
A 220-foot monument stands on Breed's Hill in Boston, where the Battle of Bunker Hill took place on June 17, 1775. Here Colonel William Prescott and his patriots — instructed not to fire " 'til you see the whites of their eyes" — fought Thomas Gage's British Regulars, and abandoned the field only after running out of ammunition. Although it wasn't a military victory for the Americans, the battle proved that they could stand up against British forces.





◀
Installed in 1875 to mark the centennial of the Battle of Concord, the Minuteman Statue by Daniel Chester French graces the approach to Concord's North Bridge. On April 19, 1775, the minutemen held their own and drove the British back to Boston.

▼
Constructed in 1713, Boston's Old State House is one of the oldest public buildings in America. Here in 1761 James Otis fought against the Writs of Assistance before British Governor Hutchinson, resulting in the law that prohibits the search of a house without a warrant. On March 5, 1770, the "Boston Massacre" happened in the street in front of the State House. Six years later the Declaration of Independence was read from a balcony of the building to crowds below.

A Historical Pilgrimage

Rubbernecking through Massachusetts

When I heard I'd be going to Stellafane this year, I knew I would have an opportunity to see Boston for part of a day. I could also spend a day seeing various landmarks on the way back to Boston. But there was much to see for a person interested in history — would I have enough time?

On July 31, the night David Levy and I arrived in Boston, we drove around to see the city and quite by accident spied the Bunker Hill monument. Located on what is actually called Breed's Hill, the 220-foot pillar is a scaled-down Washington monument. It marks the spot where, on June 17, 1775, American patriots — instructed not to fire " 'til you see the whites of their eyes" — abandoned the field to British regulars only after running out of ammunition, thus winning a psychological victory for Colonel William Prescott.

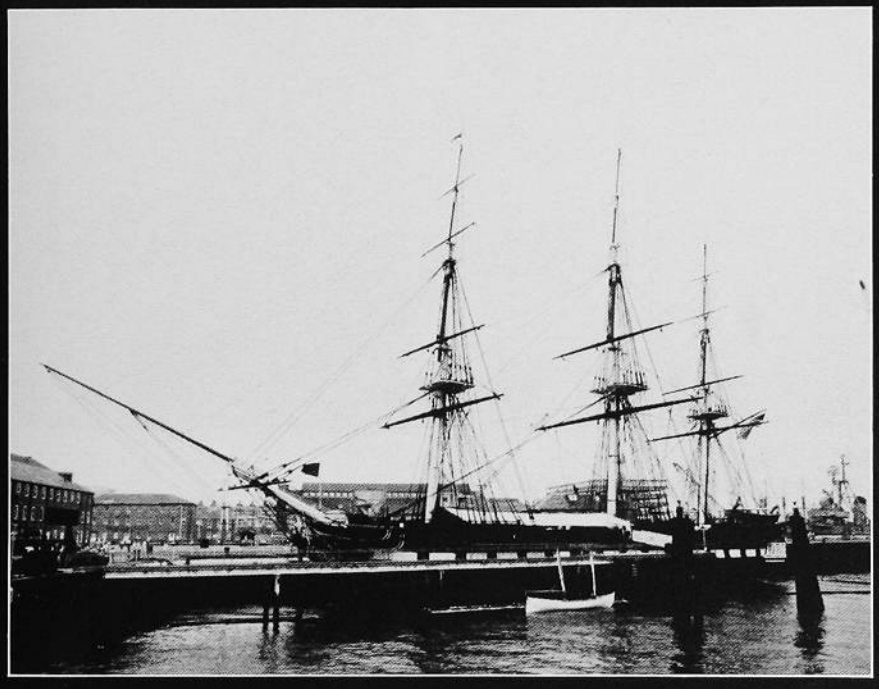
I then stopped at Walden Pond, the legendary haven of Henry David Thoreau and friends. That was the extent of it before Stellafane. But afterward I resumed the rubbernecking. First I tramped over the Concord battlefield, site of some of the Revolutionary War's fiercest fighting. The North Bridge, the Minuteman Statue, the grassy fields where gallons of blood were once spilled — all appeared serene. Nearby is the Old Manse, the boyhood home of Ralph Waldo Emerson, and onetime home of Nathaniel Hawthorne. After seeing it I went to Sleepy Hollow Cemetary to see the graves of Thoreau, Hawthorne, Louisa May Alcott, and the Emersons.

Next it was on to Lexington to see the Green where the Revolution began. It now looks like a typical city park, with a few monuments and a large flagpole — but nothing overwhelming.

In Charlestown I saw the U.S.S. Frigate *Constitution*, first commissioned ship of the Navy, and the World War II Destroyer *Cassin Young*. Then I was off to Beacon Hill in Boston where I saw the Granary Burying Ground, the ancient cemetary that contains the graves of Paul Revere, John Hancock, Samuel Adams, James Otis, and Robert Treat Paine. After lunch and a trip to Goodspeed's Book Shop, I walked across the Common to my car and drove to the Old North Church, Faneuil Hall, and the Old State House. By dinnertime I drove to Cambridge and met friends at the Harvard-Smithsonian Center for Astrophysics. I stayed at Harvard that night and returned to Milwaukee the next day, thinking that indeed one can see quite a bit of history in a few hours.

David J. Eicher.

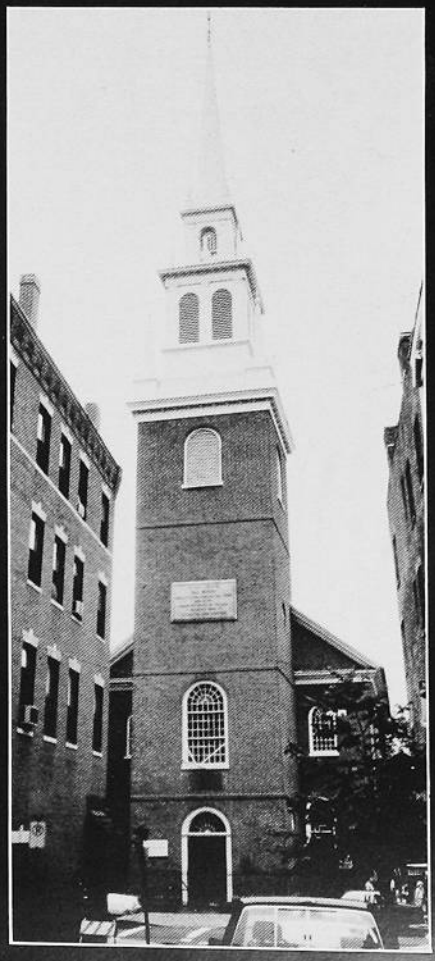
◀ *Near the Concord battlefield lies Old Manse, the boyhood home of Ralph Waldo Emerson. The house was built in 1769 by Emerson's grandfather William, who witnessed the Concord battle from inside. Here Emerson spent this boyhood years and wrote* Nature, *his first book of essays. Nathanial Hawthorne lived in the house from 1842 to 1846, and wrote* Mosses from an Old Manse *in the room where Emerson had worked.*



▶ *The U.S.S. Frigate* Constitution, *the first commissioned ship of the U.S. Navy, floats docked in Charlestown Navy Yard. Completed in 1797, the ship saw action in the pseudo-war with France, the War of 1812, and many smaller engagements. Junked in 1830 as "unseaworthy," the ship was nicknamed* Old Ironsides *in Oliver Wendell Holmes' famous poem. Holmes' protest against junking the* Constitution *raised a public outcry and the ship was restored and saved.*

▶ *On April 19, 1775, the "shot heard 'round the world" was fired on Lexington Green, beginning the American Revolution. This stone marks the position of the American line as it faced the British Army for the first time.*

▼ *On the night of April 18, 1775, two lanterns shone from the steeple of the Old North Church in Boston to warn that the British were marching to Lexington and Concord. Completed in 1723, it is the oldest church in Boston.*



continued from page 23 . . .

Also present were Mike Witkoski and Glenn Chaple, each of whom has contributed to *Deep Sky* for years. Mike's article on the Double Cluster in Perseus is this issue's lead; Glenn, who brought his son David, has written our column on double stars for nine years. Both were in excellent spirits and happy to be back at Stellafane.

Other notables were present and talked about various astronomical projects, observing sessions, telescopes, and trips to see Halley. Steve O'Meara and Alan MacRobert of *Sky and Telescope* chatted and wished for clear skies. Colleague Dennis di Cicco ensured that everything on the Hill would run smoothly throughout the gathering. Comet expert John Bortle discussed Halley's brightness with many curious onlookers. Three-time comet discoverer Rolf Meier and his wife Linda walked around and talked with several fellow Canadians. Co-discoverers David Levy and Mike Rudenko met for the first time and shared anecdotes about Comet Levy-Rudenko, 1984t.

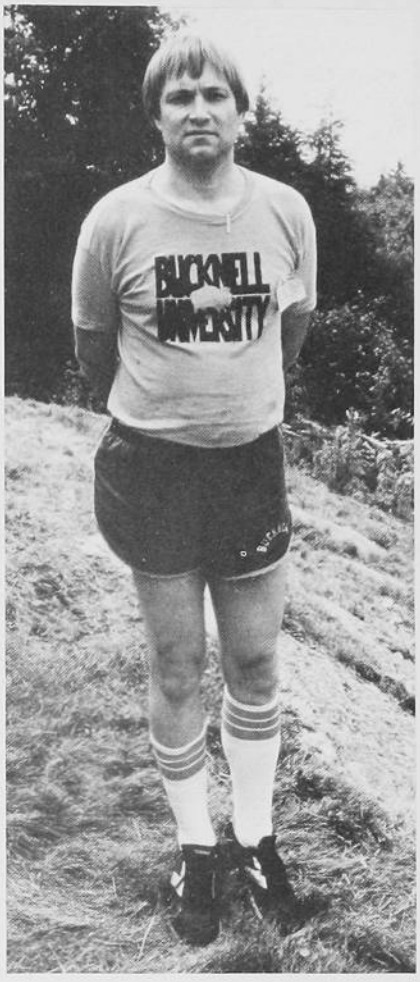
But the man of the hour was Scotty Houston. Along with his wife Miriam, Scotty was besieged by throngs of admirers who discussed his column, his work with the AAVSO, or his deep-sky observing techniques. He is the grand old man of amateur astronomy.

As darkness fell and the traditional Friday night tent talks were gearing up, the inevitable finally happened — the sky let loose with a horrendous downpour, turning Breezy Hill into a tropical rain forest. Many attendees piled into tents for the night, while many others — including me — hopped into cars and talked with old friends. Chaple, his son, Levy, and I swapped stories as we watched an impressive thunderstorm discharge its lightning in all directions.

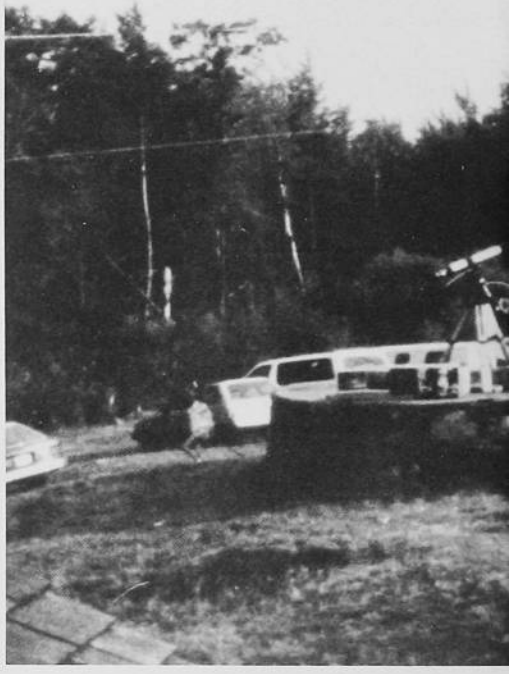
The rain had essentially stopped by the next morning, but the Stellafane grounds resembled swampland more than anything else. It had been a hard, long rain. Saturday, August 2, was a day for talking to numerous people, photographing telescopes, and by nighttime preparing for the trip back to Boston.

The day's highlight was the evening address by Brian Marsden, director of the Central Bureau for Astronomical Telegrams at the Harvard-Smithsonian Center for Astrophysics. Brian's quite humorous talk centered on crazy things that happen at the Bureau, particularly in astronomical discoveries. I listened intently along with Levy and frequent contributor Alister Ling.

Afterward, it was time to go. Stellafane 1986 was history. I said goodbyes, packed up, and drove to Concord, Massachusetts. After all, maybe next year, I thought, it wouldn't rain so awfully much. *David J. Eicher.*



▲
Mike Witkoski, a contributor to Deep Sky *for years and author of this issue's lead article, poses proudly in his Bucknell T-shirt.*

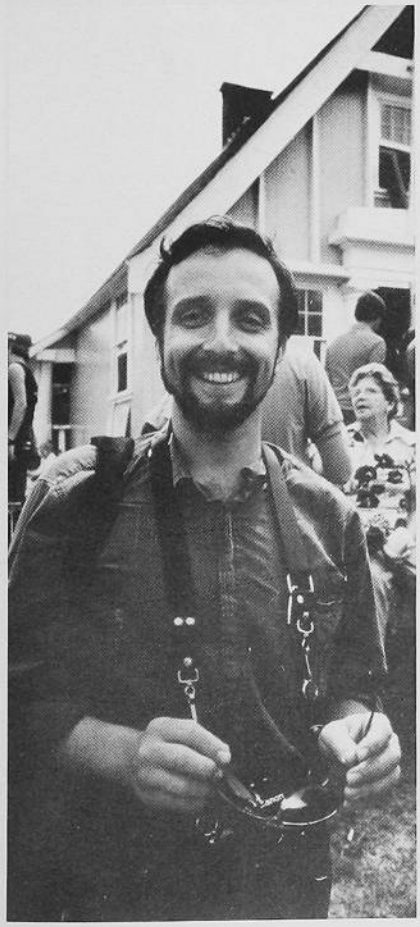


▶
Staying up too late hunting for comets makes one silly the next day, as columnist David Levy demonstrates.

▶
Well-known comet observer Steve O'Meara enthusiastically poses for posterity.

▶
Walter Scott and Miriam Houston were swamped with visitors throughout Stellafane. Scotty celebrated the asteroid that was recently named for him and counseled young observers in the ways of deep-sky viewing.

Amateurs begin to gather around the famous pink clubhouse atop Breezy Hill for the 1986 Stellafane convention.

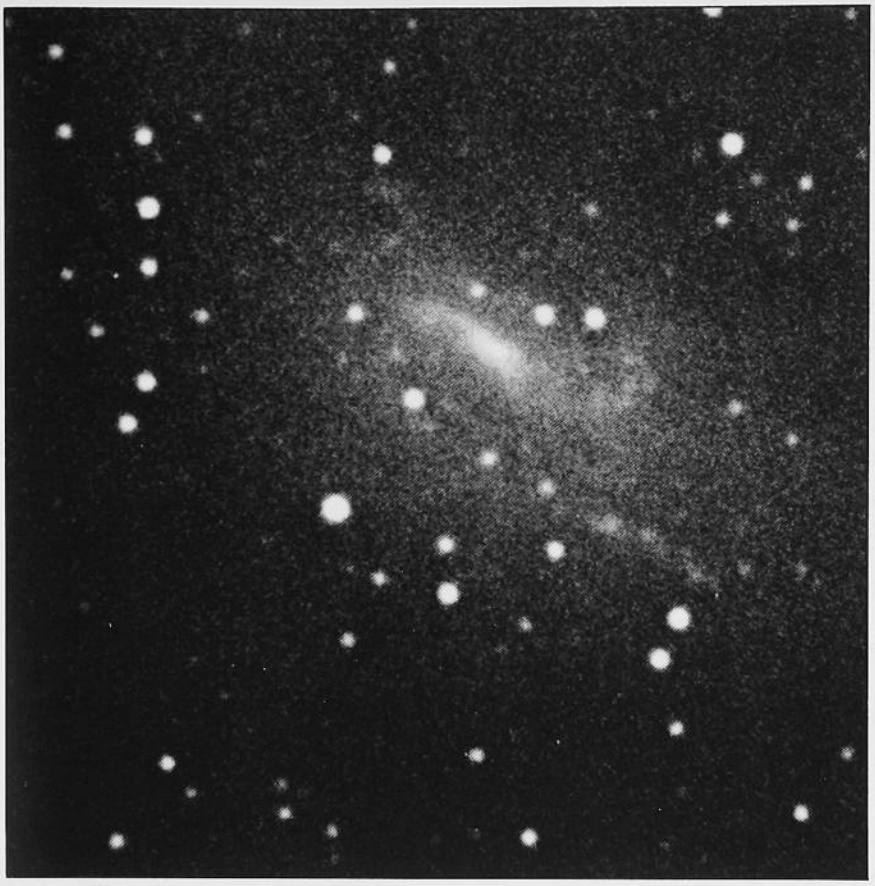


Small Scope Showcase

◀ *NGC 1023 in Perseus is a magnitude 9.5 lenticular galaxy whose high surface brightness makes it visible in small scopes. Photo by Tom Eby.*

▶ *NGC 925, a 10th magnitude barred spiral, lies just 3° southeast of the bright star Gamma (γ) Trianguli. High power on dark nights will show a faint haze surrounding the NGC 925's core; this haze is the galaxy's unresolved spiral arms.*

▼ *M31, the Andromeda Galaxy, is the brightest spiral galaxy in the sky. It spans more than 3° across and shines with the light of a magnitude 3.5 star. Photo by Jim Riffle.*



A Child's Sky

by David H. Levy

The fall sky is a child's sky, filled with colorful characters whose adventures always entrall the open minds of young people. It is the sky of Mira the wonderful, a variable star in Cetus that changes from being a 3rd-magnitude naked-eye star to a faint 9th-magnitude telescope object and back again in about 11 months. Fall is also the sky of water, with Aquarius the Water-Carrier and Cetus the Whale doing their autumnal work.

Whenever I start explaining the fall sky to a child, I begin with the tale of Andromeda, the princess whose chained predicament gave her a permanent home in the northern sky. Andromeda the constellation is a distant and colorful group, filled with deep-sky delights for a cool fall night. Let's begin with **Gamma (γ) Andromedae**, a fine double star whose stars, of magnitude 2 and 6, lie almost 10 seconds of arc apart.

Double stars often look best through long-focus telescopes like refractors and compound telescopes (Schmidt Cassegrains and Maksutovs). The long focal ratios of such instruments (f/10 to f/15) encourage high magnification viewing, which on nights of good seeing makes splitting double stars easier. While a short-focus 4-inch f/5 reflector may well "split" γ Andromedae, you can drive a dump truck between the two stars when you use a longer focus 4-inch refractor.

Now we move farther out into space away from our Galaxy to the "island universe" next door, a neighbor system of known as **M31**. Think about this for a moment. From your own backyard you can take a small telescope and peer out of our star family into the neighborhood of another. You can enjoy a journey into space that will take you some two million light-years at the instantaneous speed of thought.

When you take this voyage to the Andromeda Galaxy, you travel in two ways back into time. The first way is physical. Since light takes 2.5 million years to travel from M31 to here, you can say that you are looking at M31 as it appeared over 2.5 million years ago.

The second voyage in time is metaphorical. When you look at M31, for a moment you share your view with all the astronomers of the past who also looked at this object — from William Herschel, who first ground large telescope mirrors, to the Earl of Rosse, who sketched it using his huge reflector, to Edwin Hubble, who estimated its distance from observations he made with the 100-inch telescope on Mt. Wilson. In 1986, Herschel, Rosse, and Hubble are long-dead, but the Hubble Space Telescope is poised to go into space to observe among other objects the same Andromeda Galaxy that you can see from your own backyard.

For you, the small telescope you use is as important a tool as the great instruments of modern astronomy. The hours you spend gazing at M31 with your telescope constitute a voyage in which you share the misty light of this galaxy with every other telescope user, no matter how long ago they lived.

Andromeda has other galaxies, less well-known but just as worth viewing. **NGC 891** is a fine galaxy seen edge-on from Earth. Because it isn't as bright as the more famous edge-on spiral in Coma Berenices, NGC 4565, it's not as well-known. But its structure, mottling, prominent dust lane, and stunning appearance make it one of the sky's better sights of its type.

Another galaxy resides in nearby Triangulum, M33. It is also a member of our "Local Group" of galaxies, and while this galaxy is much smaller than the Milky Way or M31, it does turn its face almost fully toward us. Through a small 6-inch telescope we can see it as a large and diffuse spiral, and as we increase the aperture of our telescope the spiral arms become more distinct.

M33 is easy to see, but don't expect to see a bright core and lots of beautiful radiating spiral arms through your small Schmidt-Cassegrain scope. M33 has a relatively large surface area, so its brightness is distributed over so large an area that under in a city sky, you'll probably miss it altogether. This galaxy calls for low f/ratio systems with wide fields of view to maximize the contrast between the galaxy and its surrounding space.

Nearby M33 is **NGC 925**, a more challenging object, bright and, like its more famous neighbor, face-on.

If we move our sights westward into Pegasus, we find a third bright spiral, a galaxy seen almost edge-on so that it is pencil-thin. This is **NGC 7331**, a galaxy that rewards its viewers more if they travel a bit to see it. This is a "country" galaxy, seen best from under a rural sky. Take a drive away from the city lights, set up your telescope, and enjoy the view.

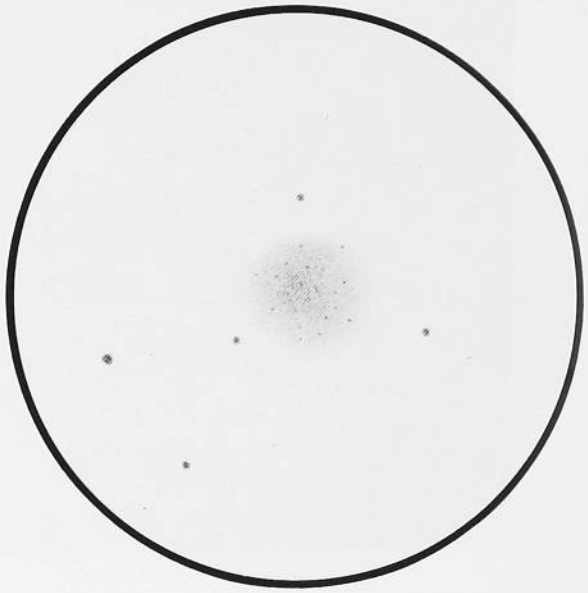
We can move east from Andromeda into Perseus for a look at **NGC 1023**, also a bright and easy galaxy. Were it not partly hidden behind some nearby Milky Way obstruction, this galaxy would really be a sight.

While we are looking at big, bright, nearby galaxies, let's try **NGC 253** in Sculptor. One of the largest galaxies in the sky, this galaxy technically has the next most-prominent spiral structure after M31. The reason this galaxy keeps its glory so secret is that its -26° declination places it low for Northern Hemisphere observers. Farther south in Sculptor, near the border of Phoenix, is **NGC 55**, an edge-on spiral system whose beauty is famous for observers fortunate enough to live far enough south to see it.

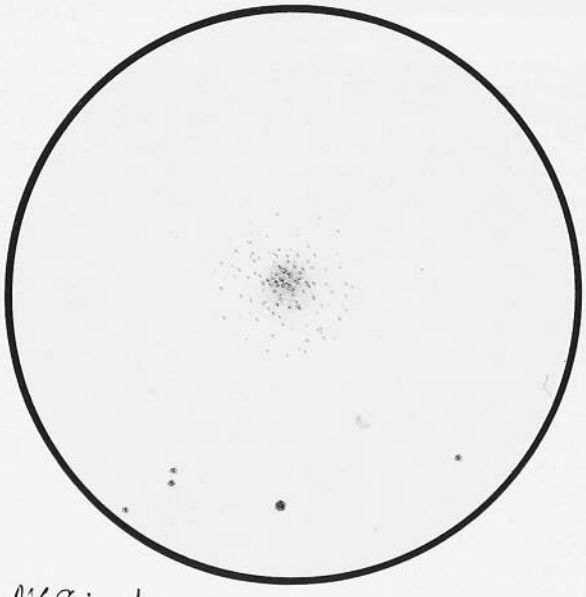
DEEP SKY SKETC

This issue's Sketch Book features drawings made by Chris Schur of Black Canyon City, Arizona. An article on observing globulars by Chris will appear in a future issue.

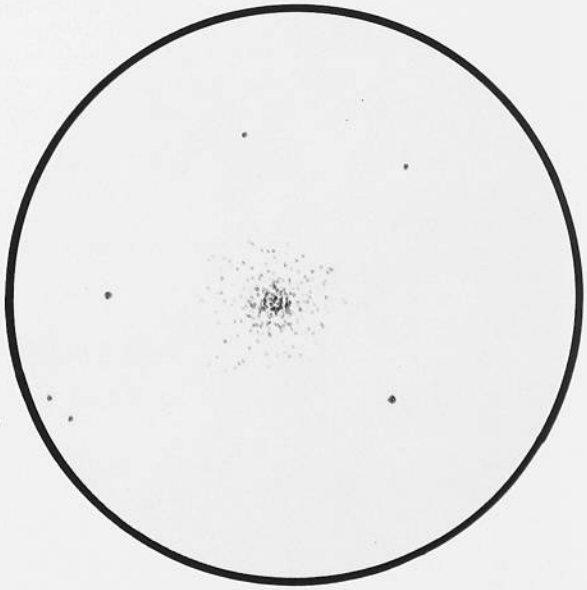
Yours truly,
D. Eicher



NGC 7492 in Aquarius
16-inch scope at 144x
October, 1985



M68 in Hydra
8-inch scope at 100x
February 17, 1985



M80
12.5-inch scope at 230x
June 9, 1985
Bright core!

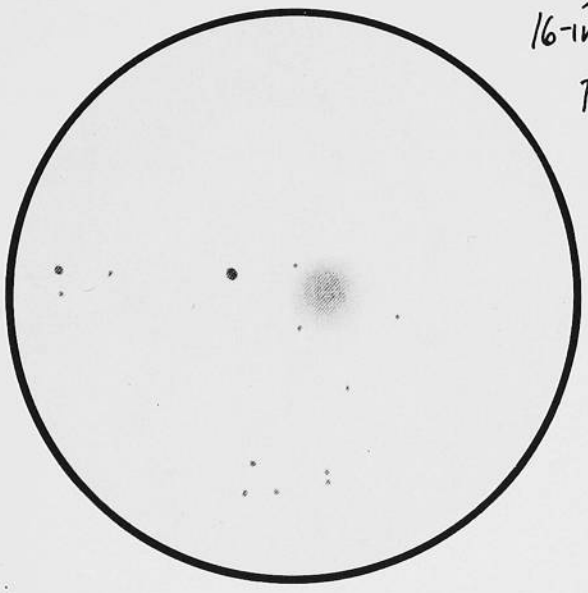
H B O O K

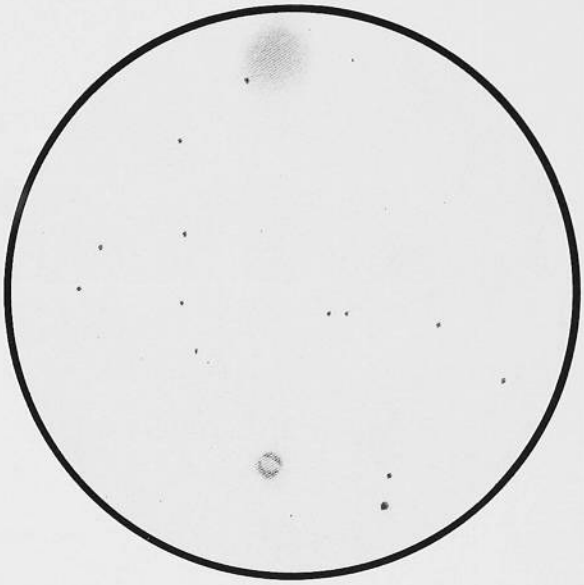
NGC 2419 in Lynx

16-inch scope at 200x

February 10, 1985

One of the remotest globulars visible in amateur scopes.



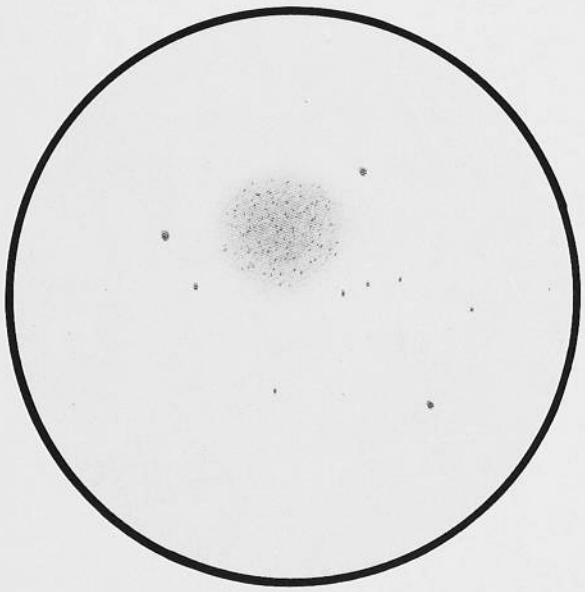


Globular NGC 6440 and planetary NGC 6445

12.5-inch scope at 130x

August 9, 1985

An example of extreme depth of field!



M2 in Aquarius

8-inch scope at 75x

November 28, 1983

Double Stars

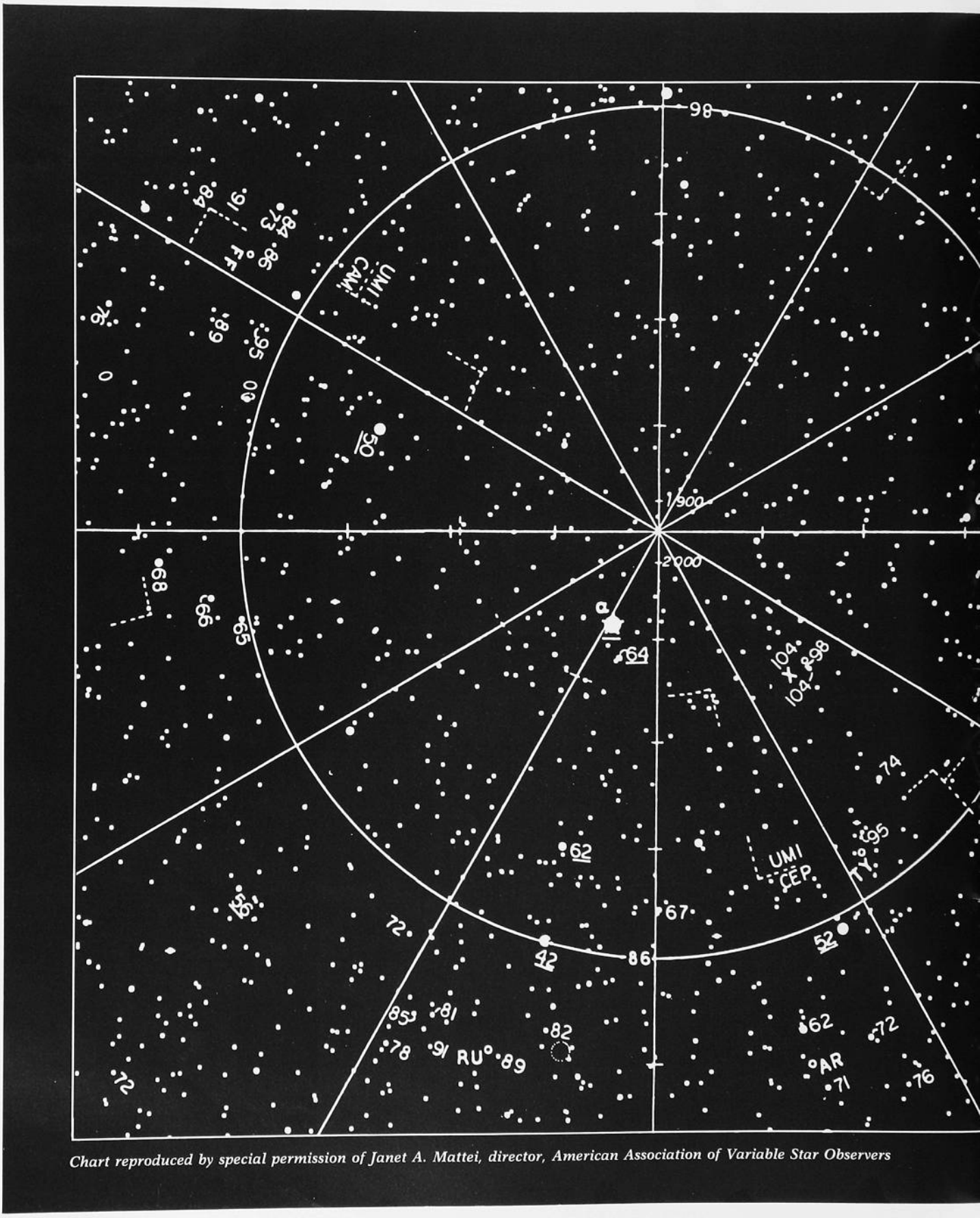
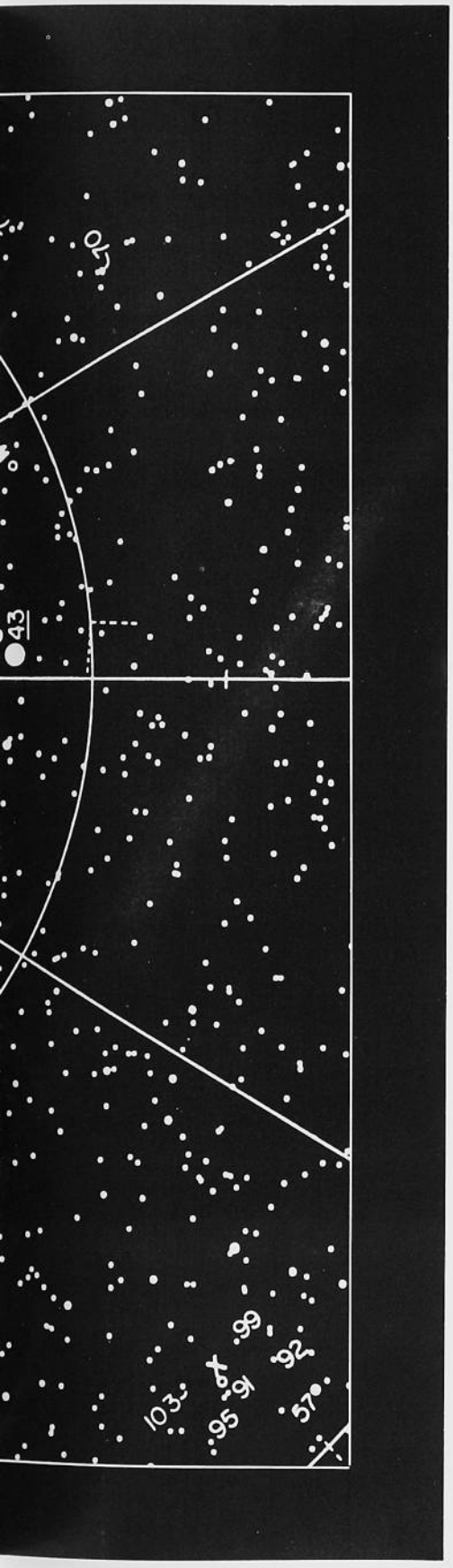


Chart reproduced by special permission of Janet A. Mattei, director, American Association of Variable Star Observers

Exploring the Polar Night

by Glenn F. Chaple



Yours truly has finally entered the 1980s. This statement is sure to astound friends who are convinced I'm lost somewhere in the twenty-third century. Anyway, the event that catapulted me out of the horse-and-buggy era was my purchase of a word-processing home computer. Yep — this article is being typed onto a TV screen (we computer types refer to it as a monitor), where I can edit it to my heart's delight. No more wastebaskets full of crumpled papers, no more clumsy typewriters, and NO MORE MISTAKES!

Our double star odyssey takes us north this time around. In fact all of our featured pairs lie within 8° of the north celestial pole. This area may appear barren to the unaided eye, but it contains its fair share of telescopic treats.

Polaris. I can't think of a better, more conveniently located light test for small telescopes. The 2nd-magnitude primary is over 600 times brighter than its companion, located 18 arc-seconds away. Using a 3-inch reflector, I need a combination of a high magnification and steady seeing to ferret this faint little star out of the overwhelming glare of the primary.

The challenge vanishes when you scrutinize Polaris with medium to large aperture scopes: I've never failed to see both stars through a 6-inch scope and the yellow and blue colors of the component stars are readily apparent. Although Polaris was first resolved by William Herschel in 1780, it bears the Struve catalog designation Σ93. The distance to this slow-moving common proper motion pair is over 300 light years, which means that the main star is perhaps 1600 times brighter than our Sun.

Ursa Major contains two more Struve paris. The first of these, **Σ1583**, is a somewhat faint pair, but still fair game for small scopes if you know where to look. "Where" is about 3° from Polaris in an area located by extending a line from 2 UMi (which now lies in Cepheus, though it keeps its old designation) through Polaris an equal distance beyond. About 60x captures both components of **Σ1583**, plus a 7th-magnitude field star. The magnitudes and separation of this relatively fixed duo are 8.2 and 9.2, and 11.1 seconds, respectively. About 2° northeast of ε UMi, you'll find **Σ2034**, whose magnitudes are a bit brighter than those of 1583, but whose 1.4-second separation requires an aperture of at least 4 inches.

Three other constellations inhabit the region north of +82°. Of the trio, only Draco fails to possess a pair listed in *Burnham's Celestial Handbook* and observable through amateur-sized instruments.

Cepheus sports a handful of worthwhile pairs. Small scopes will resolve **Σ343** (8.6,9.4; 29.5"; 325°) and **Σ2873** (7.1,7.4; 13.7"; 69°). The first is rather faint and shares a 1° field with a 6th-magnitude unrelated star. **Σ2873** is a pretty double that has shown a rather gradual decrease in position angle over the years. The spectra of this pair are F5 and G5 (pale yellow and deep yellow), but because of brightness contrast, the fainter star may appear bluish. What colors do you see?

The remaining "name" doubles in this circumpolar area belong to Camelopardalis. Lying almost exactly on the 82° parallel of declination is **OΣ117**, a wide (67") magnitude 6 and 8 pair. I first observed this duo on a night of sub-zero temperatures. Watery eyes wouldn't permit me to detect the golden yellow color that the K-type primary should display.

One of the prettiest double stars here is **Σ1694**. Located less than 2° northeast of **OΣΣ117**, these sparkling white A-type stars are a comfortable 21.6" apart. **Σ1694** was my first Camelopardalis double star — a fitting introduction to the many overlooked treasures that inhabit this obscure constellation.

If you own a 4-inch scope, seek out **Σ1479**. The separation of this magnitude 9 and 10 double is 4.6", a gap that any 2- or 3-inch scope could easily bridge were the component stars brighter. Two more Camelopardalis pairs will challenge those of you with 6- to 8-inchers. Try your luck with **Σ784** (9.5,9.5; 1.2"; 205°) and **Σ1720** (9.2,9.5; 1.8"; 334°). The position angle of the former is slowly increasing, while the latter pair remains relatively fixed.

Five years ago in this publication, I proposed carrying out a double star survey that would locate faint, wide pairs not currently listed in the major catalogs. Many such pairs, easily observed with small scopes, exist. Aided by what I expected to be a horde of *Deep Sky* readers, I had hoped to systematically observe all stars plotted on the *AAVSO Variable Star Atlas*, logging any uncatalogued pairs encountered. Such a monumental task requires a large work force — and since none of the expected horde ever materialized, the project died.

Nevertheless, several of us did explore the section of sky shown on AAVSO Atlas Chart #1 — namely, the area north of +86° declination. We stumbled upon several of the pairs already described in this column. We hit paydirt, too, uncovering a handful of maverick pairs. Their locations are shown on the accompanying finder chart, and their "stats" are included with the data for the other pairs. Why not check out these doubles and see if your magnitude, separation, and position angle estimates agree with mine?

82 South Harbor Road
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Variable Stars

A Column of Lists
by David H. Levy

Surprise! No new stars this month, just new ideas. Here are three lists that should make your variable star observing less variable:

List 1: How to Make a Variable Star Estimate

Choose stars sensibly. Is it likely to be visible through your telescope, or is it obviously too faint? At the other extreme, is your star so bright that observing it is a waste of your good telescope time? Plan carefully.

Find the star. If you have not observed it before, this could be difficult. Be careful not to misidentify it. Often variables are reddish; look for their color.

Become familiar with the field. Get acquainted with the star's surroundings and see which stars are recommended as comparison standards.

Choose two comparison stars. One should be slightly brighter than the variable, the other slightly fainter. If you can find a third that also is within half a magnitude of what you think the variable is, use it also.

Make your estimate by comparison. Compare the variable to the comparison stars you have chosen. For example, if your comparison stars are magnitude 11.5 and 11.9, and the variable is much fainter than 11.5 but just a bit brighter than 11.9, then record it as 11.8. If you have a comparison star of 11.3, use it and the 11.9 star and estimate again. Do you still wind up with 11.8? After a few tries, you will get a feel for the process, and the confidence with which you make your estimates will increase.

List 2: Things to Worry about

The telescope. Each variable star probably has its own best combinations of telescope and eyepiece. As a general rule, use only enough power and magnification to see the variable clearly. Do not have it so bright that it is hard to estimate. Ideally, the variable should be about two magnitudes brighter than the faintest star you can see with your telescope. If it is much fainter than that, you'll have problems detecting the star, and if the variable is several magnitudes brighter, your ability to make subtle brightness distinctions will be swamped.

Do you have more than one telescope? Set them up before a big session and plan to use each telescope for the stars best suited for it.

Mounting. Some variable star observers recommend that you use an equatorial mount for your observing because the alignment of the chart will always be the same. My experience says this isn't a significant problem, so use whatever mounting you are comfortable with.

Field of view. Occasionally you can spend time looking for a star field in your telescope when you are unsure just how much of the chart area appears in a single telescope field of view. Use the field circle that some of the charts offer in this book, or make a wire ring equivalent to field size that you can physically move about your charts.

Weather. Try to keep the weather conditions consistent during your observing. Very thin cirrus clouds are especially dangerous because you may not be aware of them yet they will litter your observing records with errors.

Moonlight. The blue light that the Moon spreads across the sky can affect your observations, especially those of bright red variables. These tricky stars deserve dark, moonless conditions.

Light pollution. Short of moving to a dark site, there's little you can do about removing the great sources of light pollution in a large city. Light baffles may work well, however, in blocking your neighbor's porch light.

Purkinje effect. With very red stars, light builds up on your retina like light on a photographic film and the star may seem to brighten as you observe. To avoid this illusion, use quick glances, small apertures, or defocus the image.

Averted vision. The technique of looking "out of the corner of your eye" on faint objects is very successful for extended objects like galaxies and nebulae, and it can work for faint variables too. But go easy — beginners sometimes find that using averted vision a lot leads to a queasy feeling.

Breathing Exercises. Zen and the art of variable star estimating? Well, not quite. But some observers take three or four deep breaths and then hold their breaths to increase their personal faint-light limit by a few tenths of a magnitude. The idea is that momentarily increased oxygen to your brain increases your visual acuity for a few seconds. I have never found it to work well.

Altitude. The closer a variable is to the horizon, the more its light will be affected by atmospheric extinction. Since stars of different colors apparently react differently, try to observe the star at its highest possible altitude on a particular night. If you don't it won't hurt terribly, but try.

Date. Take care not to use the wrong date! Since Julian days, the way most observers submit varies by 24 hours. Universal Time is several hours ahead of the standard North American time zones.

Patience. The longer you look for a star, especially an easy star, the more aggravated you may become and the longer it's going to take to find the star. How long can it take to find one star? Tell yourself it may take all night and don't worry about it.

Organize. Plan your program in advance, but be flexible since the sky often offers surprises.

Relax. Comfort in observing is more than a luxury. If you are worried about something, your work may suffer. We all have off-nights; learn to recognize them and don't push it if you're not in the right mood.

List 3: To Ruin a Good Session

Wind. A windy night can be more devastating even than clouds. You have set up your telescope and are struggling valiantly to keep it on its mounting. Gusts of wind cause your eyes to weep, your eyepiece to fog, your papers to blow away, and your vocabulary to increase in color content.

Cloud. Not (plural) clouds that simply keep you inside, but cloud (singular) that parks itself in front of your favorite variable. Just as it is time to go indoors, the cloud gets thinner and disappears.

Police. You are desperate to observe R CrB before it sets over your neighbor's window. With one hand focusing the eyepiece and the other clutching a notepad, you make your estimate just in time to be arrested for voyeurism.

Telescope. You and your telescope have just completed a four-hour drive to a quiet, dark site to observe faint variables, only your forgot your eyepieces.

Visitors. Your carefully planned observing session became a tour of the sky for all the people who just arrived at your doorstep.

Lights. The night your neighbor has 200 people and newly installed flood lights will be the same night you miss that long-awaited SS Cygni outburst.

Children. In a spirit of good will you have encouraged your young nephew to examine your telescope. Later that evening, the sticky feel of your favorite eyepiece proclaims how much the little dear learned about telescopes!

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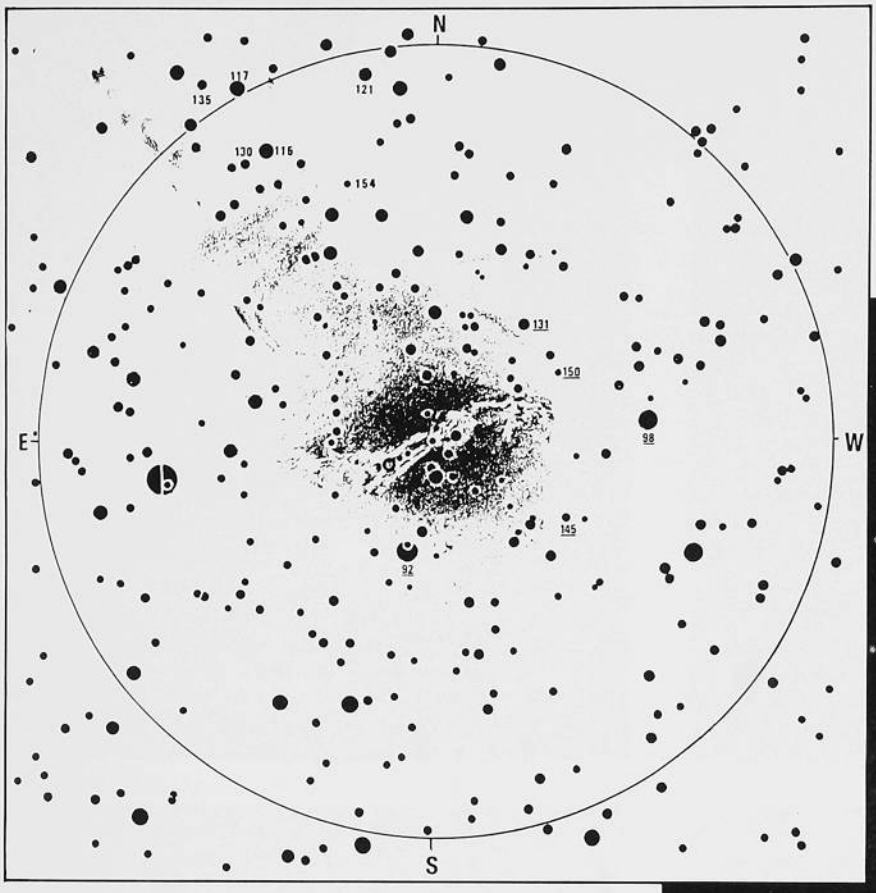
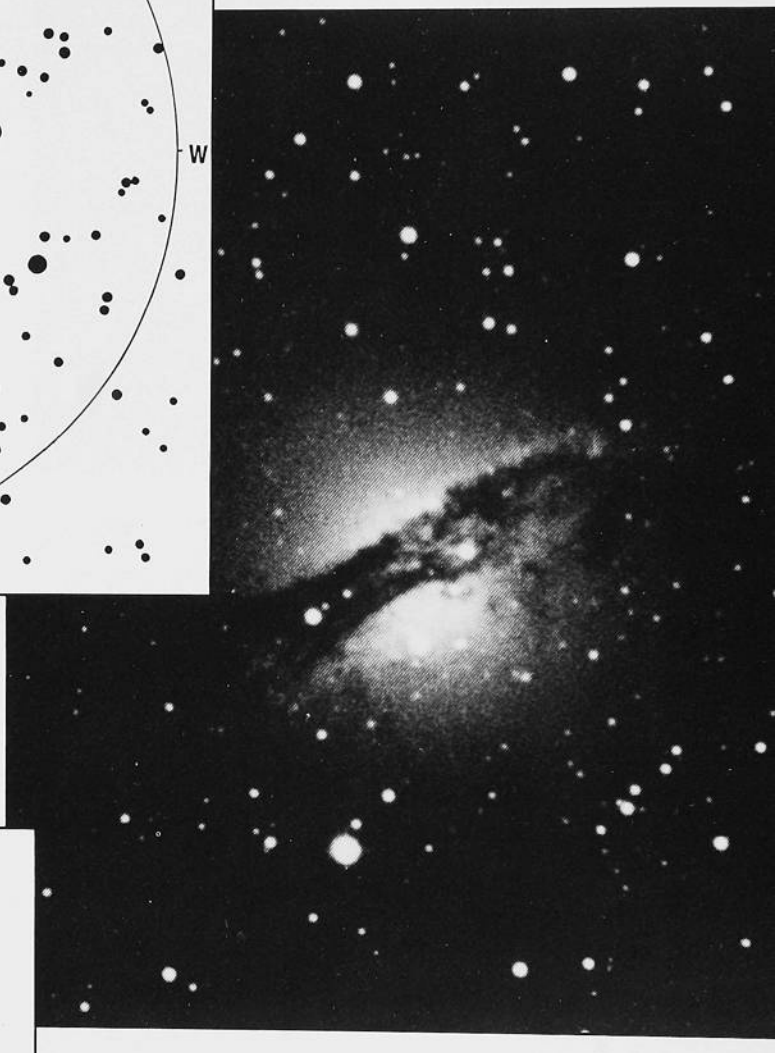
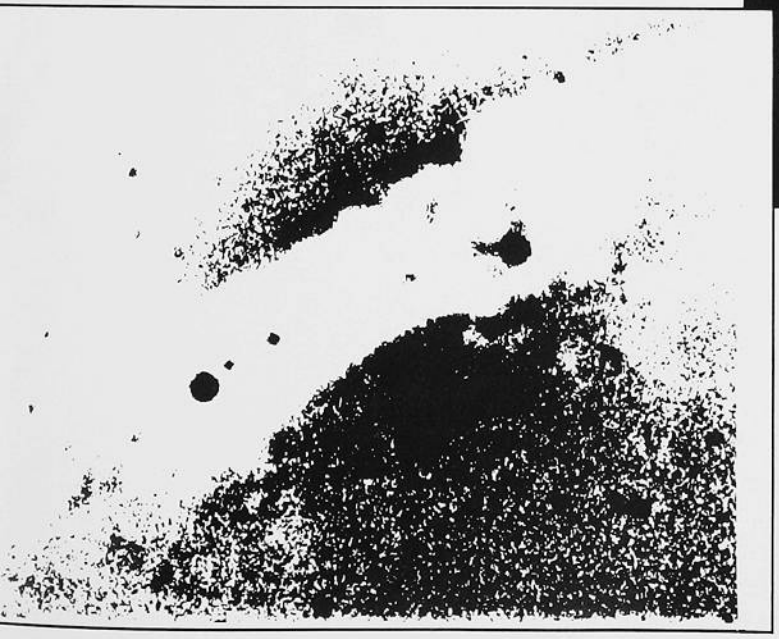
Photo Feature



◀ *Many observers saw the magnitude 12.0 supernova in the nearby galaxy Centaurus A (NGC 5128) this spring. This chart shows its position in the southeastern half of the galaxy's broad dust lane. Finder chart by Gregg Thompson.*



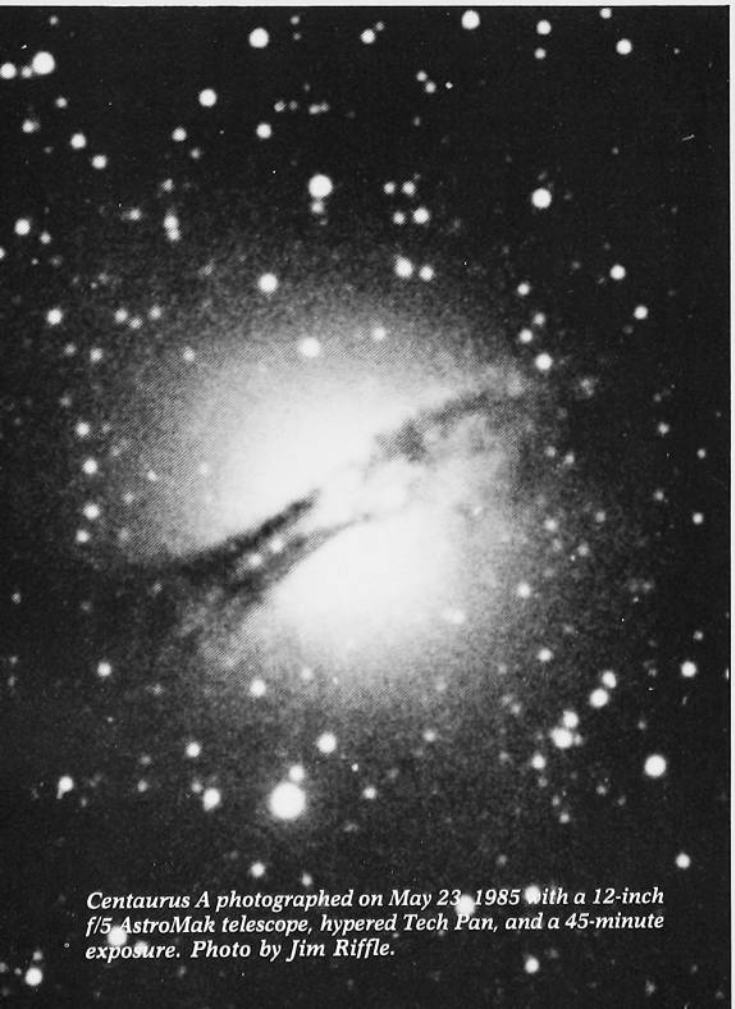
▶ *A photograph made with the 3.9-meter Anglo-Australian telescope by Colin Humphries shows the supernova about three hours after its discovery by Australian Robert Evans. The discovery date was May 3.6 UT. Courtesy Robert Evans.*



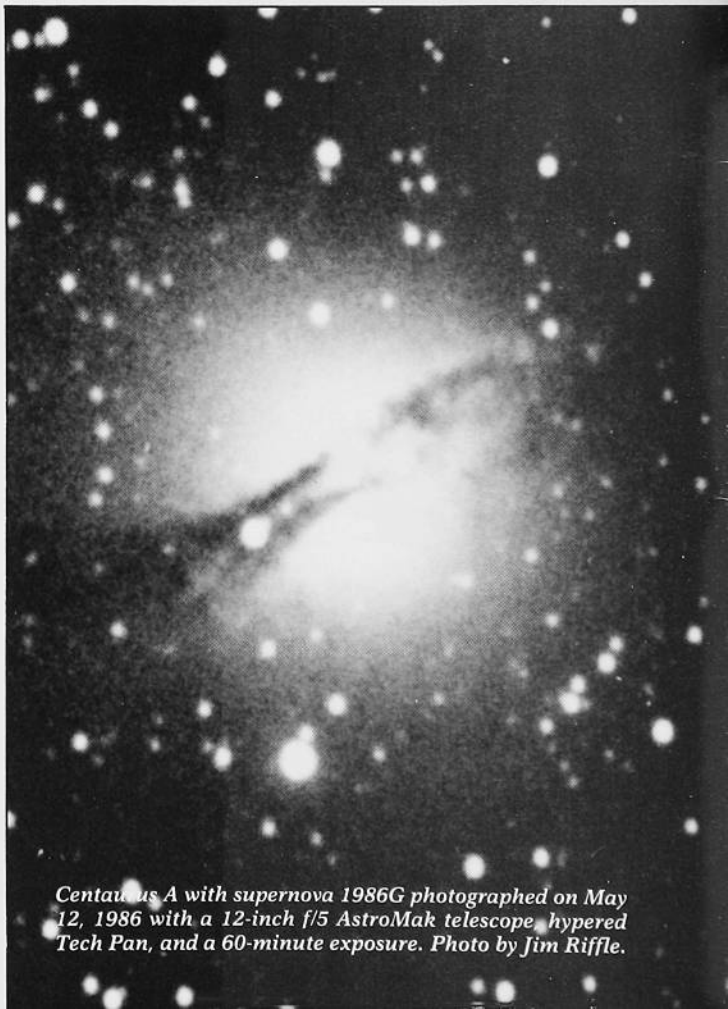
◀ *An enlarged section of the Humphries photo shows the detail present in the dust lane on May 3, 1986. Courtesy Robert Evans.*

Centaurus A photographed in 1985 with a 12.5-inch f/6 Newtonian, HP 5 emulsion, and a 30-minute exposure. Photo by Jim Barclay.

Centaurus A with supernova 1986G photographed on May 6, 1986 using an 8-inch f/6 Newtonian, HP 5 emulsion, and a 30-minute exposure. Photo by Jim Barclay.

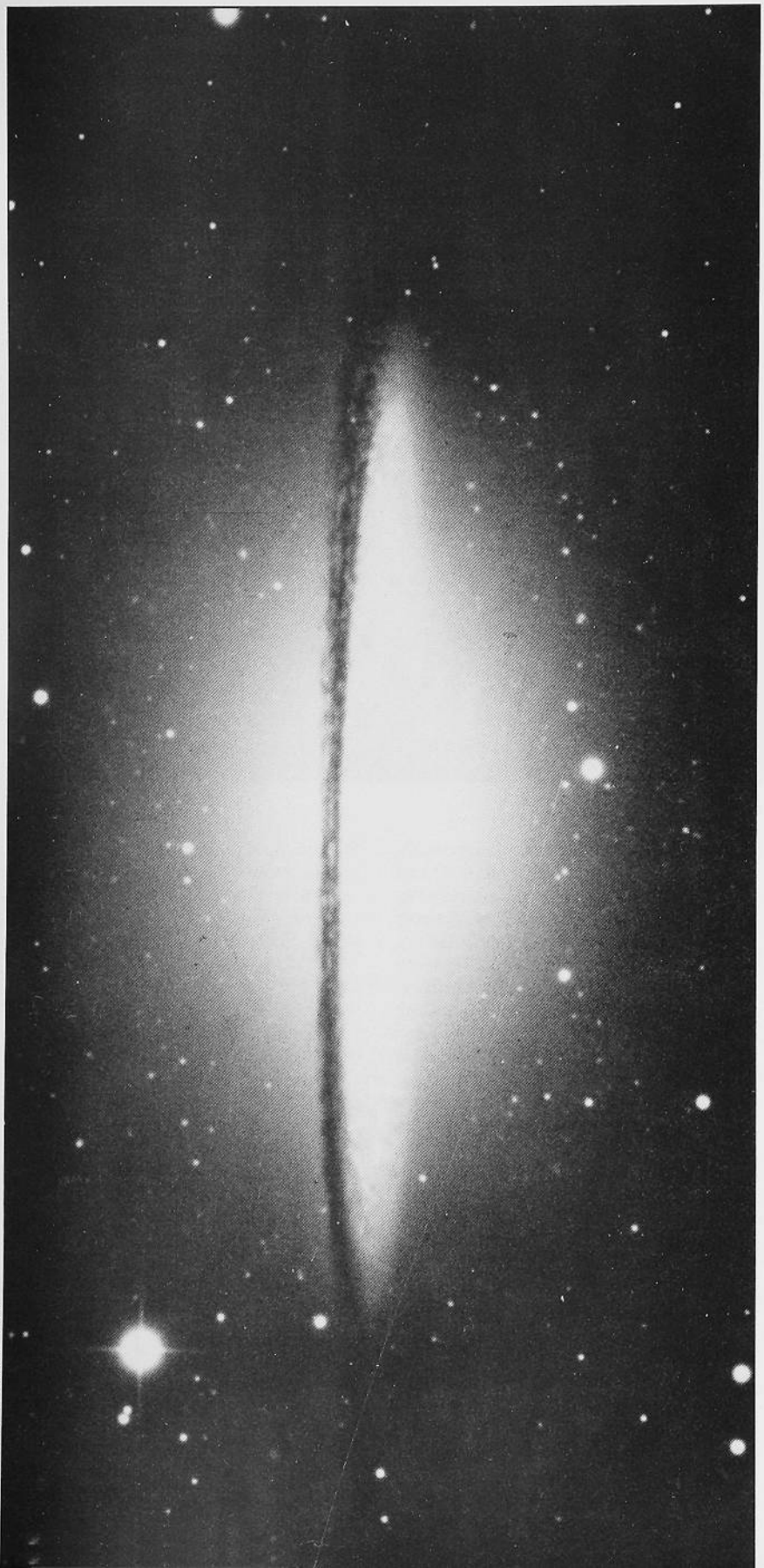


Centaurus A photographed on May 23, 1985 with a 12-inch f/5 AstroMak telescope, hypered Tech Pan, and a 45-minute exposure. Photo by Jim Riffle.



Centaurus A with supernova 1986G photographed on May 12, 1986 with a 12-inch f/5 AstroMak telescope, hypered Tech Pan, and a 60-minute exposure. Photo by Jim Riffle.

Scanning the Literature



Anglo-Australian Telescope Board

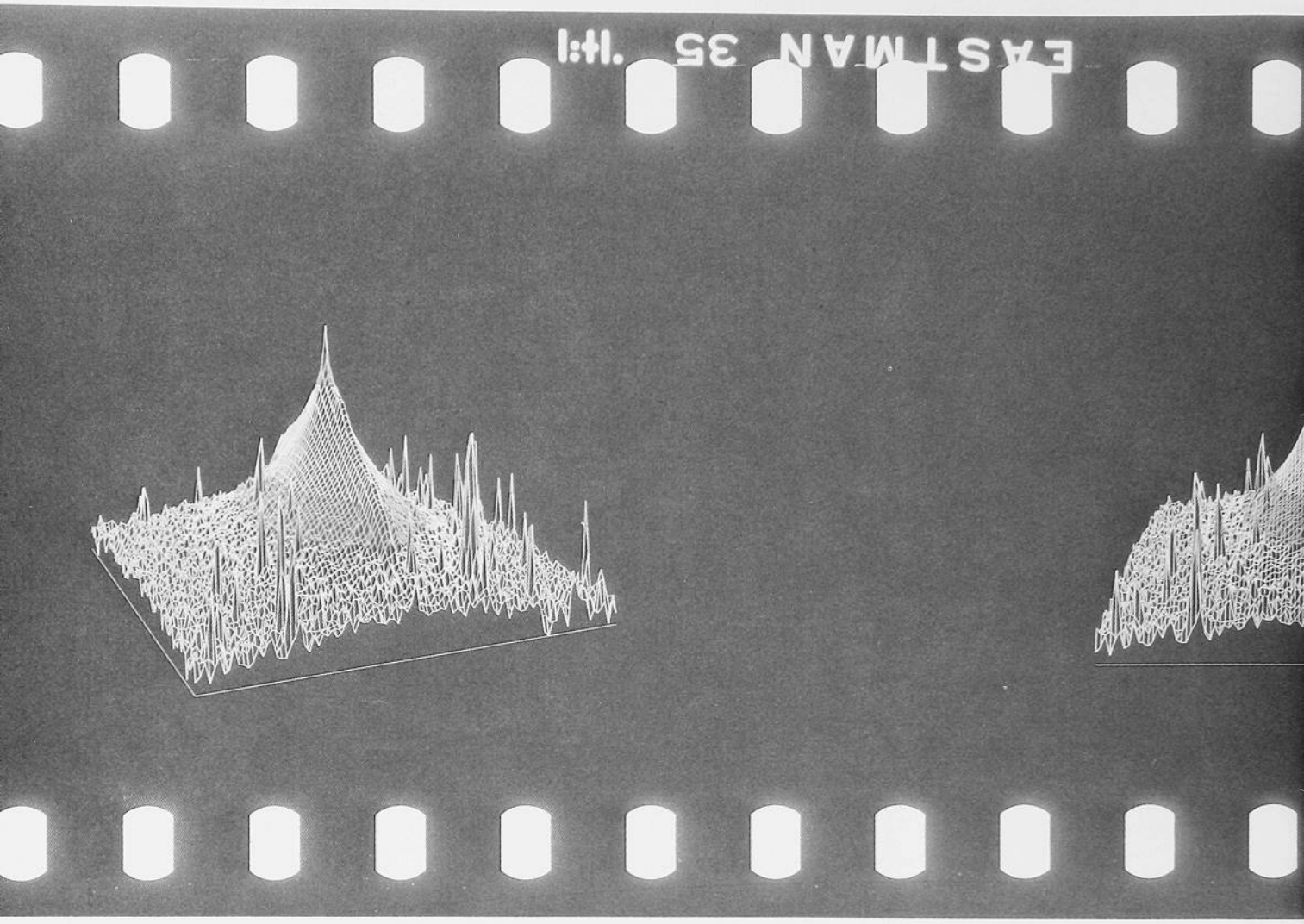
February 1986 — May 1986

by Brian Skiff

A big news item on the cosmological scene recently has been confirmation that most galaxies appear to exist on the surfaces of bubble-like structures containing large voids. A vivid illustration of this phenomenon is given in "A Slice of the Universe" by V. deLapparent, M.J. Geller, and J.P. Huchra (*Astrophysical Journal [ApJ] Letters* **302**:L1, March 1, 1986). The paper examines the distribution of redshifts of 1,100 galaxies brighter than magnitude 15.5 in a 6° x 117° strip of sky. About half the velocities were determined in an ongoing survey conducted at Mount Hopkins by a group from the Harvard-Smithsonian Center for Astrophysics.

The resulting plot of redshifts as a function of Right Ascension (essentially, looking down on a plane extending outward from Earth) resembles, in the authors' words, "a slice through suds in the kitchen sink." The rich Coma cluster, which was included in the survey, appears to lie at the intersection of two large bubbles; the velocity dispersion in the cluster contributes to a "finger of God" at that position pointing toward the observer (us!). The presence of the bubbles, their size, and their sharp boundaries pose substantial constraints on cosmological theories. Though one model does permit these structures to exist, most models account only for large-scale strings or filaments of galaxies, not nearly-empty shells. Rest assured that a flurry of new studies is underway!

Detailed examinations of nearby individual galaxies continues; one is "A Photometric Study of M104" by Martin Burkhead (*Astronomical Journal [AJ]* **91**:777, April 1986). Using photographic plates made in five colors, Burkhead did surface photometry in five colors in the visible and near infrared wavelengths which extend to large angular distances from the center of the galaxy. Visual observers often note that the center of M104 is very bright. Photoelectric measures of the near-nucleus region show that a spot 5″ across and centered on the nucleus is equivalent in brightness to a star of V magnitude 12.5; a 10″ spot emits light equal to a V magnitude of 11.5. The surface photometry ex-



hibits no evidence of absorption of the nuclear light by the dust lane within 6″ of the center.

The galaxy becomes remarkably circular in its outer regions beyond the 20′ diameter. At the reliable limits of the measurements (only a few tenths of one percent of the night sky brightness), the galaxy extends to at least 40′ in diameter and has an integrated magnitude of B = 8.71 within this area, which compares to an integrated magnitude of B = 9.27 given in the RC2.

One of the 3-D contour maps of the galaxy included with the article (and on the cover of the April *Astronomical Journal*) shows a profile of the bright ellipsoidal "bulge" component, the thin disk, and a remarkable end-on view of the wall-like dust lane.

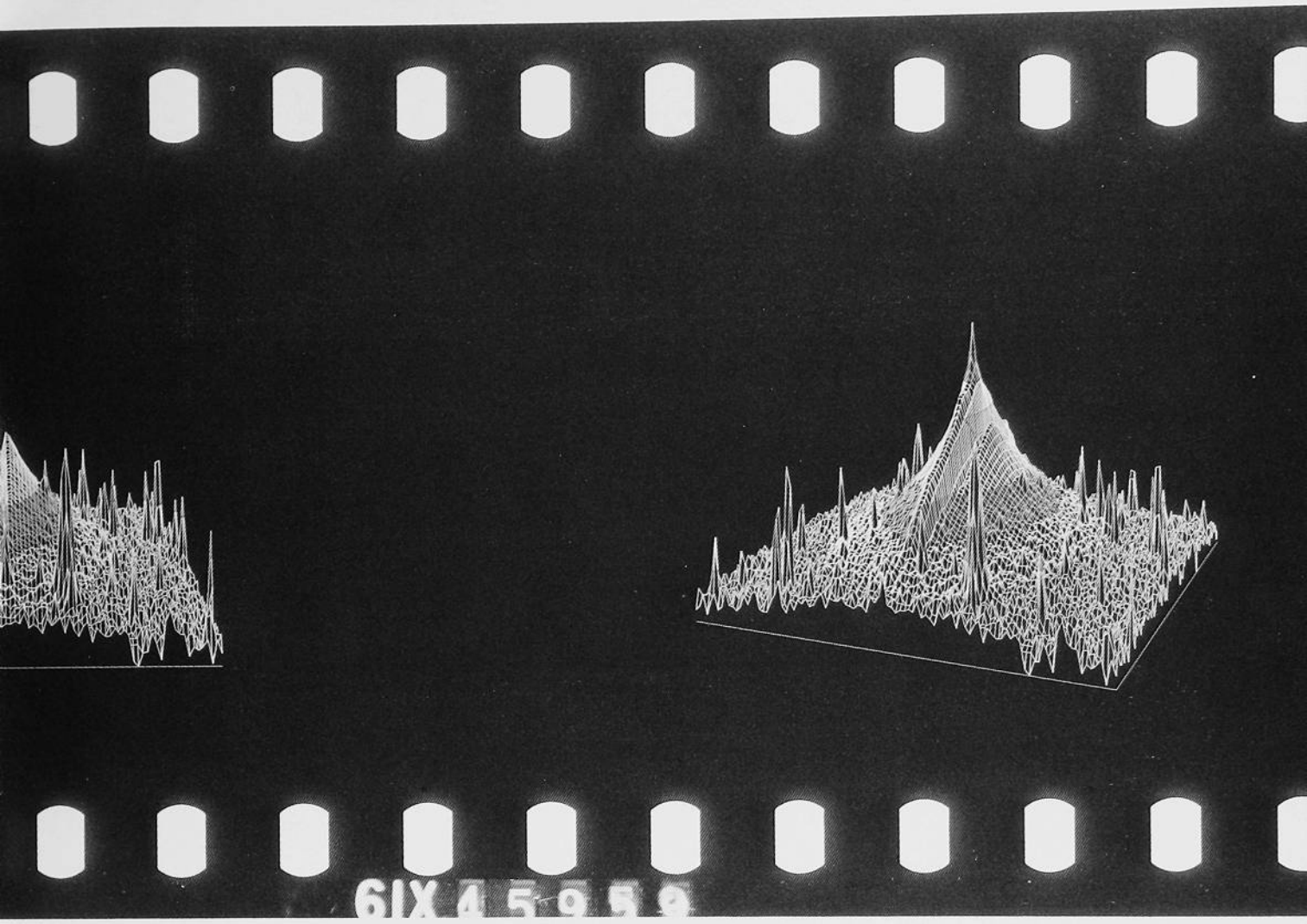
A little closer to home we have new work on two Local Group dwarfs, "The Brightest Stars in Nearby Galaxies. VII. The Pegasus and Leo A ImV Dwarfs" by Allan Sandage (*AJ* **91**:496, March 1986). Photographic photometry to V = 21.5 of the brightest resolved stars in these nearby galaxies is presented along with photographic finder charts and photoelectric measures of bright stars (between magnitudes of about 12 and 17) in the field around the two objects. The color-magnitude diagrams show features similar to other Local Group members, being dominated at the very luminous end by blue and red supergiant stars. Based on these, Sandage finds approximate distances of 2.5 Mpc for the Pegasus dwarf and 1.5 Mpc for Leo A.

In the cataloguing department is a useful but not earth-shaking paper by a group of Italian astronomers, "Accurate Positions of Zwicky Galaxies. I" by G. Vettolani, G. Palumbo, and N. Santagata (*Astronomy & Astrophysics Supplements (A&A Suppl.)* **64**:247, May 1986). Positions measured from the Palomar Observatory Sky Survey (POSS) prints are given for about a thousand galaxies in thirteen POSS fields, covering a region near the bright, rich cluster Abell 262 (at about 2h and +36°). The authors intend to measure all 30,000 galaxies in Zwicky's compendious *Catalogue of Galaxies and Clusters of Galaxies* with a mean error of about 5″, compared to one or two arc*minutes* of error for the original CGCG positions.

Photometric study of another halo globular cluster is reported in "Color-Magnitude Diagram of Palomar 14: CCD Photometry" by Carol Christian and J.N. Heasley (*ApJ* **303**:216, April 1, 1986). Magnitudes and colors were measured for hundreds of stars as faint as magnitude 25 with a CCD camera attached to the CFH telescope in Hawaii.

The astronomers found that the cluster is relatively metal-rich despite the absence of blue horizontal-branch stars in the color-magnitude diagram — a phenomenon typical of outer halo globulars but unusual for clusters closer to the galactic center. Christian and Heasley infer the distance to be about 105 kpc and the age of the cluster to be about 15 billion years. For observers wishing to ferret out this distant system visually, a photo showing the field of the cluster is included with the article.

Two interesting articles on open clusters appeared in the February *Publications* of the Astronomical Society of the Pacific. "The Intermediate-Age Open Cluster Mel 71" by Marc W.



Martin S. Burkhead's photometric study of the Sombrero Galaxy (M104) produced this multi-angle three-dimensional surface photometry of the bright galaxy. Courtesy Bill Jack Rodgers, Los Alamos National Laboratory.

Pound and Kenneth A. Janes (PASP **98**:210) deals with a relatively rich cluster in southern Monoceros. Photographic magnitudes and colors are presented for nearly 600 stars in the field of Melotte 71. At a distance of 2.4 kpc, the cluster is dimmed by about one-third of a magnitude by interstellar absorption. The authors also find its age to be nearly a billion years, which is similar to the age of the Hyades.

"The Bright Yellow Giants in the Open Cluster Berkeley 82" by Douglas Forbes (PASP **98**:218) focuses on a much younger object: a sparse cluster in Aquila. UBV photoelectric photometry for twenty stars to V magnitude 15.5 is given, and star counts on a photograph show that the cluster is 10′ in diameter. Though it lies at a distance of only 980 pc, the cluster is dimmed three magnitudes by intervening dust. Forbes estimates the age of the cluster to be 60 to 80 million years, which is around the age of the Pleiades.

The two brightest stars are yellow bright-giants of spectral type G2 Ib-II and K2 II, and the third brightest member is probably a blue B giant. These three stars provide about eighty percent of the light output of the cluster. The photometry here adds up to an integrated magnitude of V = 9.1, which includes the faint nonmembers to more or less compensate for incompleteness.

Another spectroscopic analysis of multiple stars is reported in "The Ages and Dimensions of Trapezium Systems" by Helmut Abt (*ApJ* **304**:688, May 15, 1986). The article provides MK spectral types for 120 stars in 31 systems considered to be trapezia (groups of three or more stars whose separations are roughly equal). Abt found many purely optical components in the groups; half of the systems turned out to be normal multiple stars where fainter companions are dominated by a luminous — and more massive — "central star" analogous to the Sun and its planets.

There were, however, eleven true trapezia in the sample. All but one of these are younger than the Hyades. Abt suggests that the magnitudes for stars tested in the Lick IDS catalogue are about half a magnitude too bright — between V magnitude 9 and 13. Among the interesting systems is ADS 11060, which appears to consist of a nearly quadruple star superimposed on a distant triple.

On the astrometric side of double star work there is "Orbits of 20 Visual Binaries" by Wulff Heintz (*A&A Supp.* **64**:1, April 1986). The new or revised orbits reported here are mostly for very close pairs with rapid motion. The orbits range from ADS 6825, which reaches a maximum separation of 0.19" in 1992 to ι Leonis (ADS 8148), which is currently widening from a 1986 separation of 1.34″. (This separation is not too tough for a sharp 8-inch telescope in good seeing.) The impressive article includes the orbital elements as well as a tabulation of all the observations and their residuals plus ephemerides for each system through the turn of the century.

Galaxy Group Stephen's Quintet

National Optical Astronomy Observatories photo